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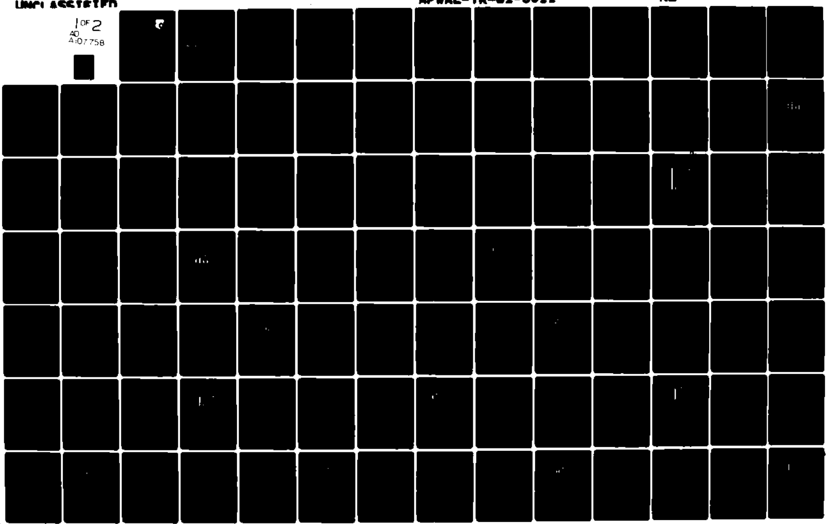

AFWAL-TR-81-3011

PILOT WORKLOAD
A SURVEY OF OPERATIONAL PROBLEMS

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Electronic Systems Division
Westlake Village, California

August 1981

Final Report for Period April 1979 - September 1980

Approved for public release; distribution unlimited

FLIGHT DYNAMICS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
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Five hundred and seventy three USAF pilots responded to a survey which had as its objective the identification of operational, crew station design related causes of high pilot workloads. The survey consisted of mailed survey forms and personal interviews structured to conform with the "critical incident technique" of collecting user-provided data. The survey canvased over 50 USAF organizations in collecting data for more than 30 currently flown USAF aircraft types. The role control/display design, crew station design, and equipment malfunctions play in contributing to cockpit workload is unique to

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each aircraft. Other factors, such as weather, flight schedules, and mission phase appear to contribute to cockpit workloads in most all the aircraft surveyed. Further, the reported situations, or "critical incidents", indicate that high workloads result from the simultaneous occurrence or existence of several causes. For example, a high workload situation reported for the FB-111 consisted of an equipment failure while flying the low-level penetration portion of a mission at night. All data collected has been catalogued for the establishment of an information base, and available for future use in conjunction with aircraft development programs or modernization/retrofit programs.

FOREWORD

This report documents the results of a survey of more than 500 USAF pilots. The objective of this effort was to identify, based on the operational experience of the pilot, the features of the crew station design and other related aspects of the mission and/or crew which were perceived as the underlying causes of high pilot workloads. The data collected through this effort are retained in an information base for potential use in new aircraft development programs and/or aircraft modernization or retrofit programs.

The survey was performed by the Bunker Ramo Corporation under Air Force Contract F33615-78-C-3614. The work was performed in support of the in-house work unit "Workload Problem Assessment" (Work Unit 24030411) of the Air Force Wright Aeronautical Laboratories. The work was monitored by Mr. Larry Butterbaugh of the Crew System Development Branch, Flight Control Division, Flight Dynamics Laboratory, Air Force Wright Aeronautical Laboratories, Wright-Patterson Air Force Base, Ohio. This report documents work performed during the period from April 1979 to September 1980.

The authors wish to express their appreciation to the hundreds of pilots and organizational contacts which were necessary to allow this effort to be accomplished. These persons were the cornerstone of the entire survey and their willingness to contribute to the development of better, safer aircraft is commendable. A special expression of gratitude is extended to Miss Vickie Lovely for the many hours of assistance provided throughout the preparation of this report.

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SECTION I

INTRODUCTION

As evidenced by recent publications (References 1, 2, 3) operator workload research continues to be directed, primarily, toward the definition, prediction, and measurement of mental workload. As a result, excellent theoretical constructs of the human behavior components of mental workload, as well as assessors of mental workload, have been developed. In the context of researching and developing practical, optimal-workload, man-machine interface designs for airborne systems, however, the workload variations resulting from the dynamic nature of the task and the environment cannot be overlooked.

In 1978, the USAF Inspection and Safety Center reported a study which analyzed destroyed aircraft mishaps for the preceding year and a half (Reference 4). The reported frequency with which such workload related factors as 'task saturation', 'distraction', 'inattention', and 'channelized attention' were cited as contributory factors in operational mishap accident reports tragically portrays a weakness in the effectiveness and thoroughness of workload assessment. Information is obviously missing during aircraft design and evaluation phases which results in an incomplete representation of the operational conditions that manipulate crew workload. This information, if known, could be applied to future aircraft development, current aircraft redesign, or current aircraft retrofit programs, thus preventing the recurrence or continuation of a crew-system-mission workload problem.

The reported survey and its results are the beginning of what is planned to be a long-term study of operational factors relating to crew workloads. Reflecting the belief that the user should be involved throughout the design and evaluation process, the approach selected was to survey pilots of USAF aircraft, rather than to analytically study USAF aircraft operations. This research was primarily interested in determining specific crew station design variables, operational mission procedure variables, mission environment variables, and aircrew preparedness (experience) variables which were encountered most frequently in high workload situations. The survey data are being retained for the initiation of a data base of the operational factors contributing to crew workloads associated with USAF aircraft.

SECTION II

METHOD

1. SURVEY FORMAT

The survey was styled as an adaptation of the critical incident technique (Reference 5). This technique calls for an investigator to obtain several direct observations of operators performing a specified task, for the purpose of potentially solving practical problems associated with the task. Flanagan emphasized the need to be flexible when applying the principles of the method, so that the needs of the specific research effort can be met. These principles are: (1) the observer should be qualified to assess the behavior he is required to describe; (2) all judgments required of the observer should be simple ones; and (3) the definition of success/effectiveness regarding the performance of the task should be the same for both the observer and the investigator.

For the purpose of this study, USAF pilots served as both the operators <u>and</u> the observers. They were asked to recall an accident, incident[1], close call, or other event that resulted in degraded performance and/or a degraded mission which was created by a high work-load situation. The survey form used to record the information obtained from each USAF pilot is shown (Appendix A).

2. RESPONDENTS

Survey respondents were intentionally confined to USAF pilots (a common denominator among all studied aircraft) to limit the volume and scope of information resulting from the survey. Two thousand nine hundred and ten pilots were requested to respond to the survey. This number was based upon the desire to survey approximately 75 percent of the pilots in a given organization. The organizations included in the survey were determined based on the aircraft to be included in the survey,

[1]The term "incident" carries a unique meaning for USAF pilots regarding the degree of damage resulting from a mishap. Therefore, rather than referring to occurrences which the pilots were asked to describe as critical "incidents", they were referred to as "events".

and the recognition that regional climatic and topographic factors might contribute to workloads. A complete list of aircraft included in this survey plus participating organizations and their locations is provided (Appendix B).

3. SURVEY PROCEDURES

The information acquired from the survey was collected for use in discovering those difficulties (i.e., high workload and its contributing cause(s)) which led or could have led to a critical situation. This study was designed primarily to reveal existing shortcomings in the human factors aspect of the cockpit design of the aircraft studied which may have allowed a greater degree of error than desirable for safe, effective flight control and mission accomplishment. However, equipment malfunctions, standard operating procedures, training/training preparedness, and external stimuli (e.g., weather, pilot error, terrain, etc.) were recognized as contributing factors of workload and were included in the study.

A pre-study was conducted in which the survey was administered to 30 USAF pilots from the 4950th Test Wing, Wright-Patterson AFB, Ohio, and tested for validity. The survey was then initiated, and continued for a five-month period, using both personal interview and mailed questionnaire.

For the mailed questionnaire portion of the survey, organizational (i.e., Wing, Squadron or Group) points of contact were established via communications with the Headquarters of the six Commands surveyed. Each point of contact was requested to distribute the survey form and accompanying instruction sheet to pilots representing a cross section of flight experience and rank. The instruction sheet mailed with the survey form is shown in Appendix C.

The number of pilots surveyed within each organization was somewhat flexible, depending upon the number of pilots and aircraft within the organization, and the time availability of the pilots. Nevertheless, with only a few exceptions, enough survey forms were forwarded to survey approximately 75 percent of the pilots within each organization. All studied aircraft types were surveyed by mailed survey forms.

The interview portion of the survey included a subset of the studied aircraft types and organizations. As in the mailed portion of the survey, those pilots interviewed were provided with an instruction sheet (Appendix C) prior to the interview, which explained the need for and kind of information to be sought during the interview. Again, the number of pilots interviewed varied, based upon pilot availability. The interviews were conducted one-on-one (one researcher, one pilot). The interviews were not tape recorded; but, notes were taken by the researchers and recorded on the standard survey form to assure that the information obtained by interviews was compatible with the information obtained by mail.

The pilots were asked to describe a high workload event or situation they had personally experienced while operating their current aircraft[1]. Prompting questions were then asked to elicit detailed information surrounding the event. Most importantly, the respondents were asked to make a judgment concerning the factors they felt had contributed to the high workload situation, and to offer ideas which, if implemented, they felt might prevent a recurrence of the problem. Finally, specific questions concerning the circumstances surrounding the event and pilot characteristics/experience were asked to allow the researchers to meaningfully categorize the responses.

Both the mailed survey and interview respondents were encouraged to describe more than one event if they so desired. Therefore, the sample received does not necessarily represent the number of <u>pilots</u> having participated in the survey, but rather the number of <u>events</u> described.

[1]Although the aircraft they were to describe had to be their current one, it was permissible for them to describe an event from a previous tour in the same type of aircraft. Familiarity with the cockpit and with the performance of the aircraft were the desired elements.

4. SURVEY CHARACTERISTICS

In 402 of the 573 responses, the pilot described a single event, as requested. Of the remaining 171 cases, some respondents related recurring high workload situations that they felt posed potential critical outcomes; others related what the researchers termed "general gripes"--comments concerning what the respondent felt to be less than adequate features of the cockpit, unacceptable operating procedures or inadequate training/training procedures which were not event-related but felt to be contributory to high workload. The authors of this report felt that much valuable information would be lost if the recurring situations and general gripes were ignored. Therefore, in describing the results to the reader, the information being researched will, when appropriate, be sorted according to whether the response was an event, a recurring situation, or a general gripe, since each implies different degrees of criticality. Appendix D provides detailed information regarding the response distributions.

5. ANALYSIS

After the data were collected, each questionnaire and interview was read and interpreted by the authors, and the responses were recorded on keypunch cards using a system set forth by the Statistical Package for the Social Sciences (SPSS) (Reference 6) to code, organize, and analyze the information received. The control cards (which describe to the computer the format of the data) and the data cards (which bear the coded information from a single response, N=537) were combined to create a data base. The data base was queried by the researchers for the purposes of this report.

SECTION III

RESULTS AND DISCUSSION

The reader is reminded that the survey of the pilots of operational USAF aircraft was for the purpose of identifying the crew station design related causes of high pilot workload. For this reason, the information presented may appear to be rather shallow, as the intention of this research was problem identification, not problem analysis. The reader will find that no attempt has been made to analyze the content or type of workload. What the reader will find is information regarding the basic source of the workload (e.g., crew station design, equipment malfunctions, training/preparedness, etc.).

The data are presented and discussed first from the perspective of overall general conditions which reportedly create high pilot workload, regardless of aircraft type. Afterwards, the reported causes of workload are presented and discussed for each of the aircraft type surveyed (e.g., A-10, F-4, B-52, etc.).

For both perspectives, frequency histograms of main workload cause, contributing causes of workload, flight phase of reported 'critical incident', pilot flying experience, and other pertinent categories are presented. In the discussion accompanying the presented data, reference is made to aircraft "missions" and various categories of workload "causes". For constancy with regard to these categories, the reader is referred to Appendix E, "Explanation of 'Mission' Categories" and to Appendix F, "Explanation of 'Workload Cause' Categories".

Also, as stated in Section II, a majority but not all the pilots responded with a specific in-flight "event". The data presented in this section are for these "event" responses only, unless stated otherwise in the figure title.

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1. GENERAL CAUSES OF WORKLOAD

It appears that high workload situations occur as a result of many factors, and most probably are the result of a combination of several factors. Workloads related to factors inherent in the control/display or crew station design are not uniformly recurring across all aircraft types, but rather appear to be dependent on the aircraft and what kind of mission is being accomplished. Preparedness (or training proficiency), in-flight procedures, and malfunctioning equipment, as contributors to high cockpit workloads, also appear to depend on the aircraft.

Some of the workload causes in the "Other Causes" category seem to appear regardless of the aircraft. One frequently identified cause is the presence of another aircraft, the ground, or other obstacle. And, as reported by the pilots, a near miss or other disaster did not have to occur to have higher workloads created. The awareness of such obstacles in the proximate area is apparently sufficient, such as the knowledge of ground proximity when flying low-level. Weather and operator errors are "Other Causes" which frequented the pilot's responses, regardless of aircraft type.

Another cause of high workload reported by the pilots, and general to all aircraft types surveyed, is the peer pressure and supervisor pressure to accomplish the mission. Many of the high workload situations which approached disaster, were in the viewpoint of the pilot, traceable to this underlying pressure to continue the mission in spite of better judgement of the pilot.

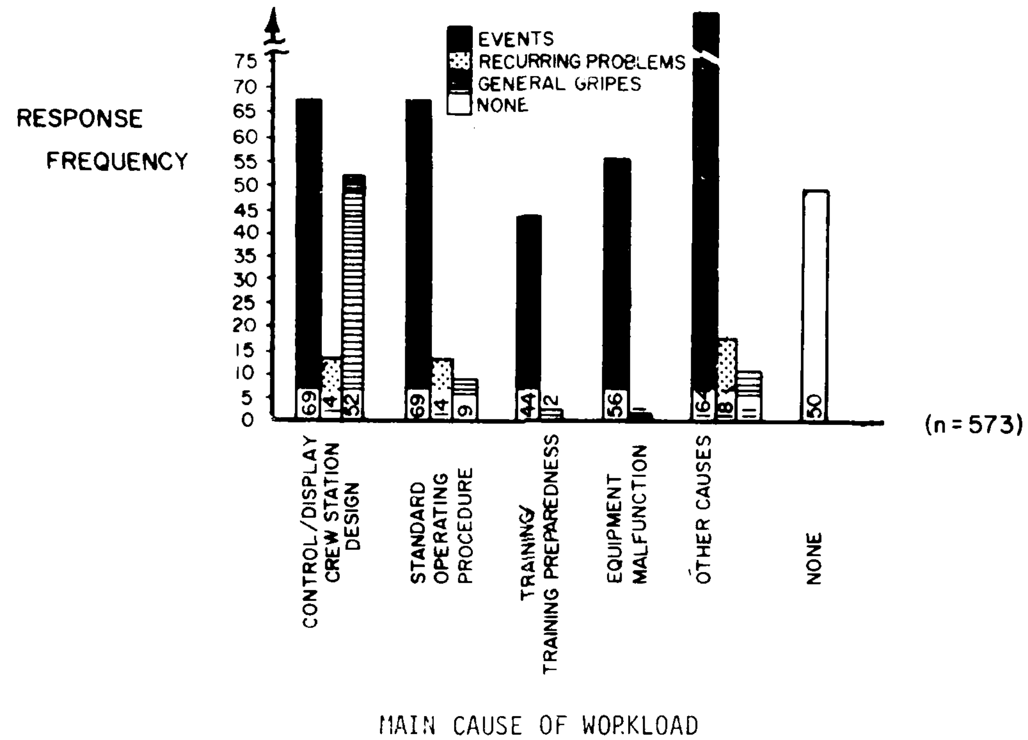

Figure 1. Frequency of Main Cause of Workload for "Event", "Recurring Prlblem", "General Gripes", and "None" Respondents

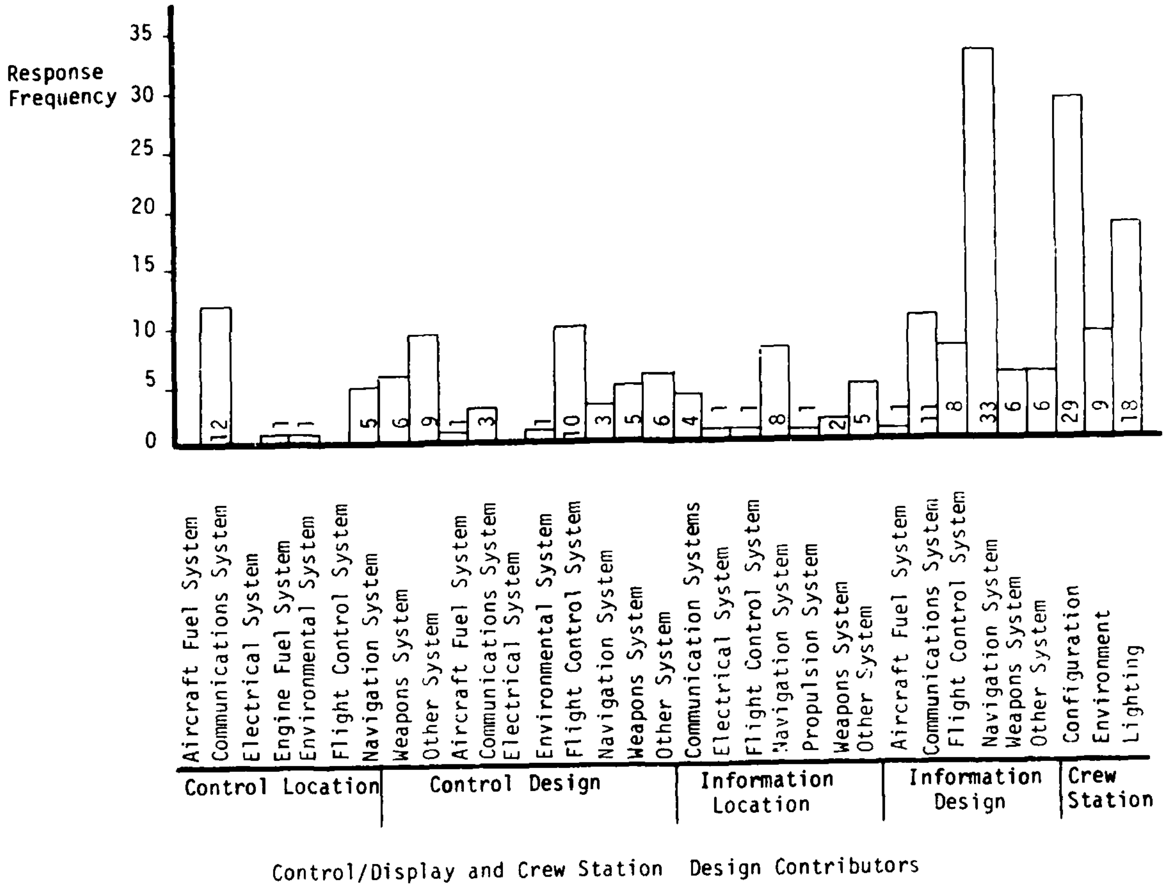

Figure 2. Frequency of Control/Display and Crew Station Design Contributors to Workload

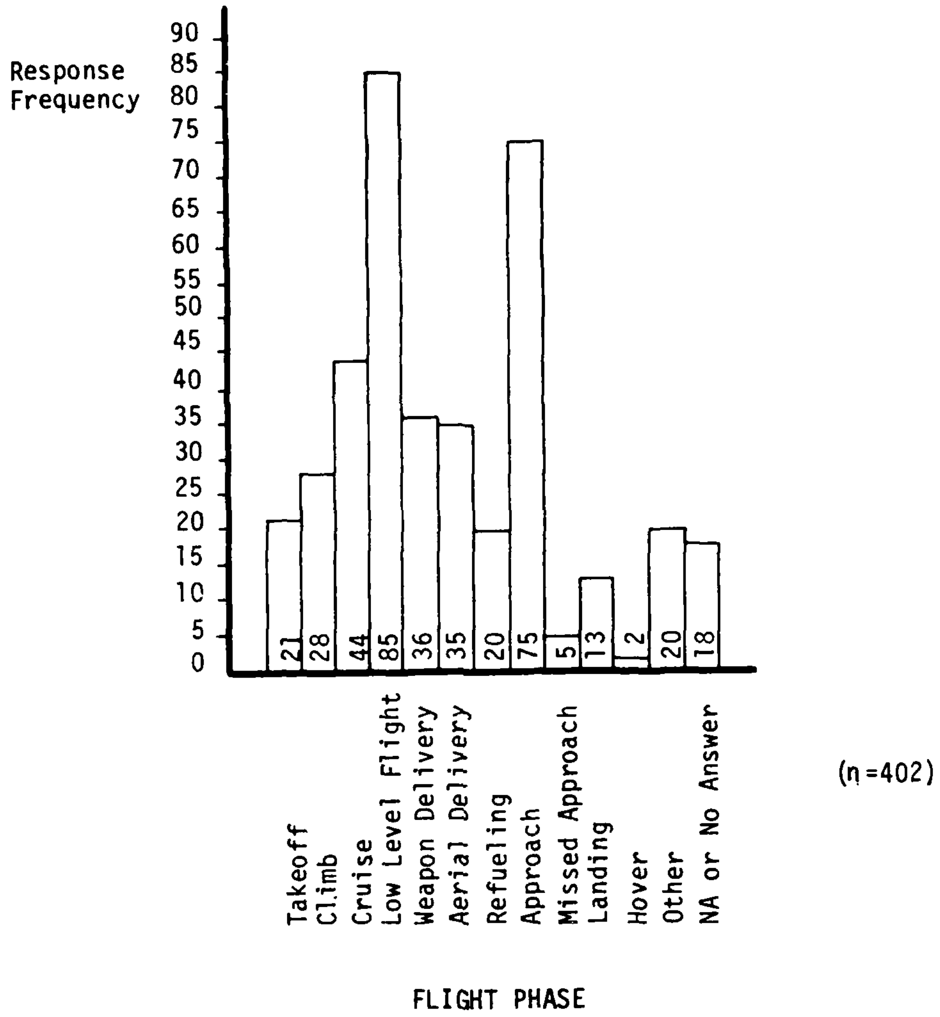

Figure 3. Frequency of Phase of Flight of Reported High Workload

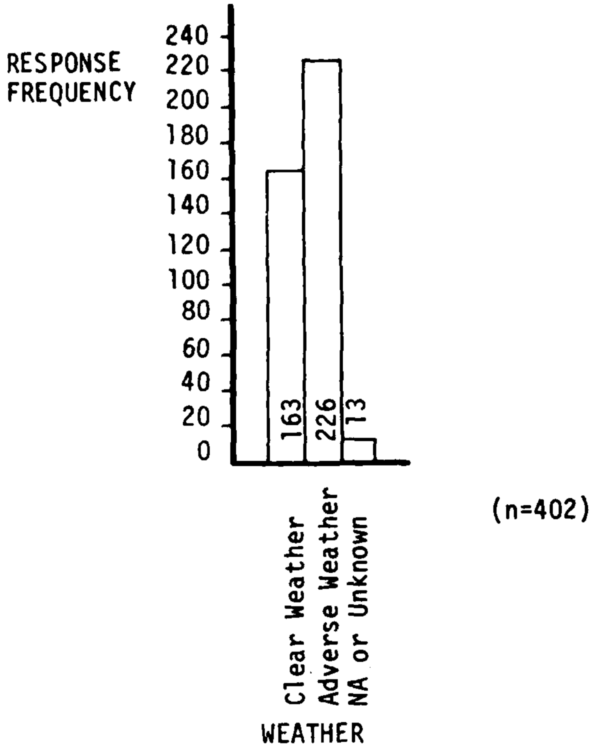

Figure 4. Frequency of Weather Condition During Reported High Workload

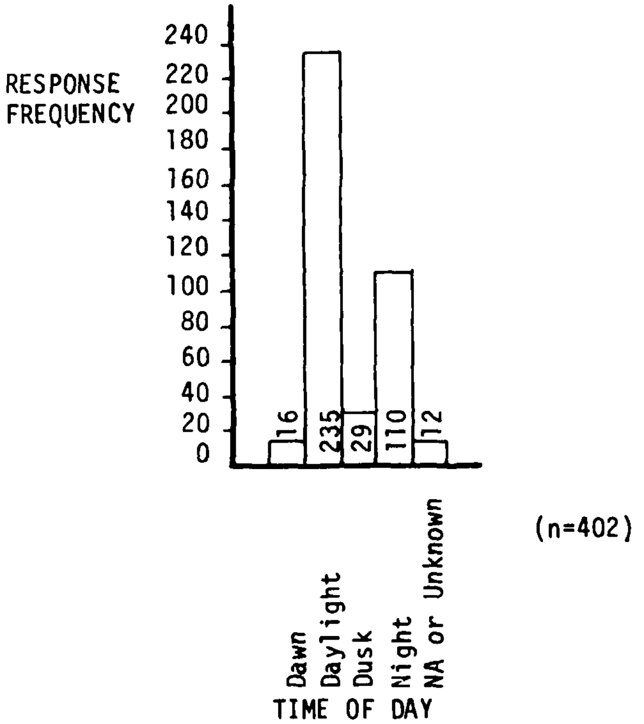

Figure 5. Frequency of Time of Day for Reported High Workload

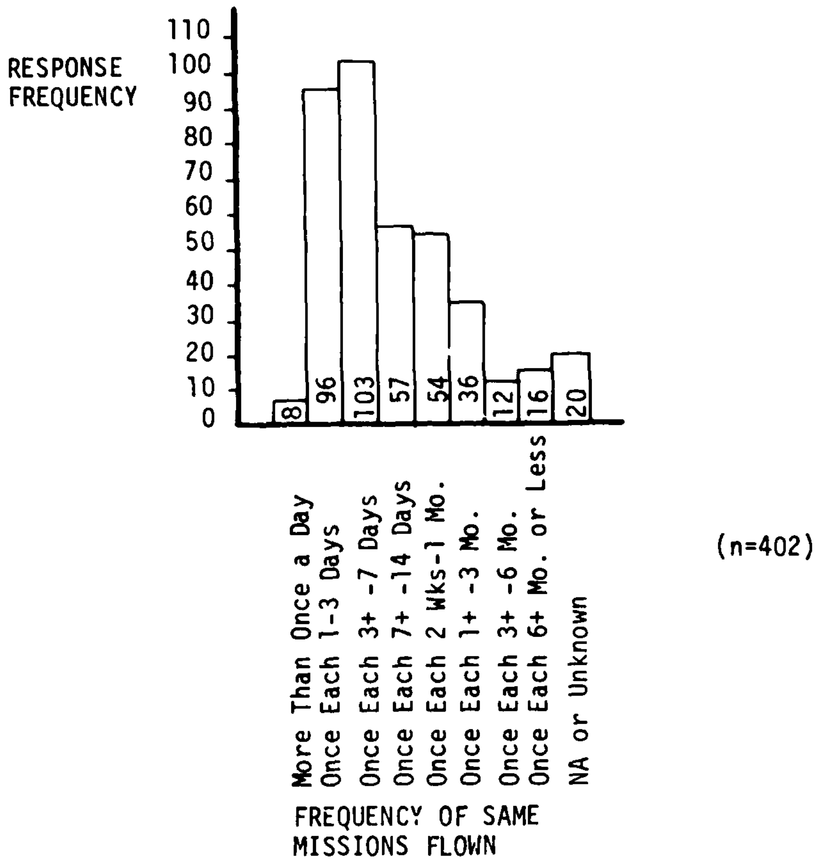

Figure 6. Frequency with Which Same Mission Was Flown at Time of Reported High Workload

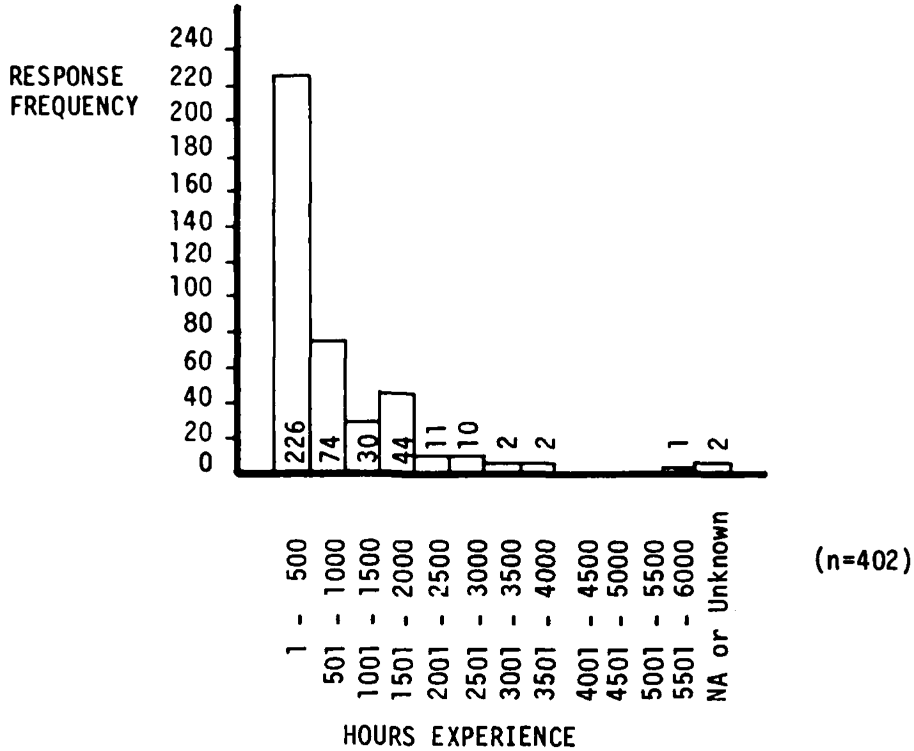

Figure 7. Number of Hours of Flight Experience in Current Aircraft Type Prior to High Workload Event

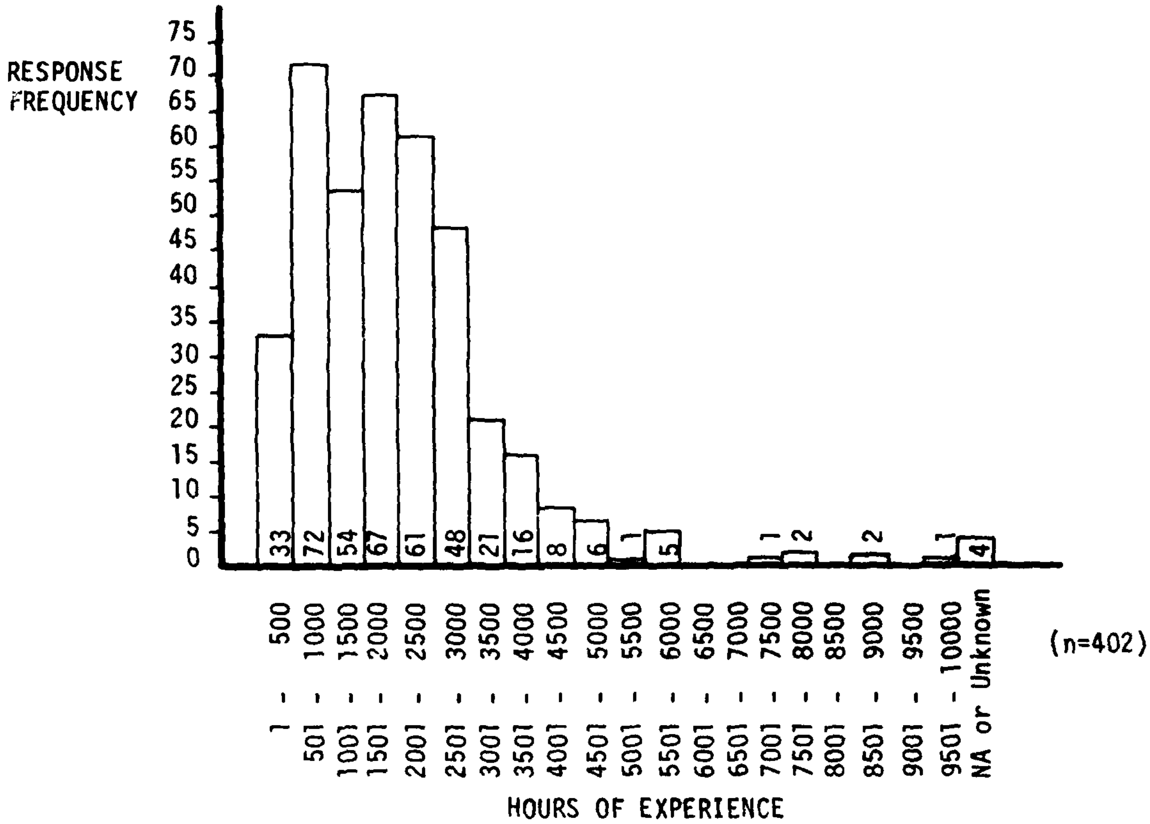

Figure 8. Number of Hours of Prior Flying Experience (all Aircraft)

2. WORKLOAD CAUSES IN USAF AIRCRAFT

a. A-10A Workload

High workloads in the A-10A appear to be most predominant with low-level flight associated with penetration to the target area. Reportedly, low-level flying in the A-10A demands head-up flying to maintain terrain avoidance. This, coupled with the need to navigate with a map (usually unfolded on the pilot's lap), reportedly produces a divided attention situation where the pilot must alternate between head-up flying and head-down map reading. The net result, indicated in the survey, is a loss of situation awareness with respect to terrain clearance and "last-second" realization of close ground proximity. Pilots recommended improved navigation systems (such as an Inertial Navigation System) and radar altitude information be provided to reduce the workload of the above situation.

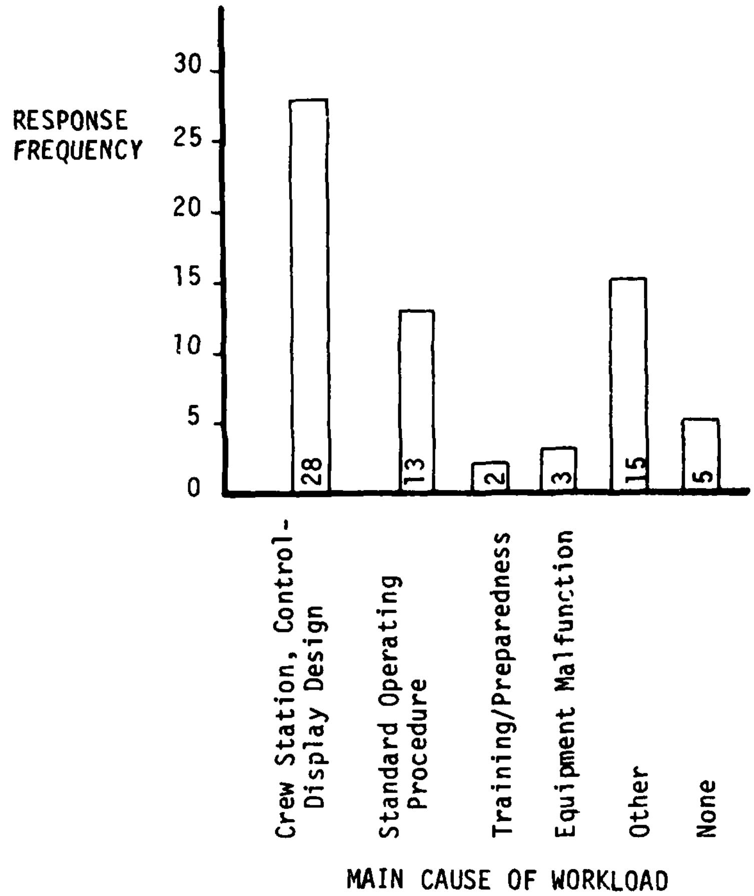

Figure 9. The Main Contributing Causes of High Workload
Reported by all A-10 Respondents (n=66)

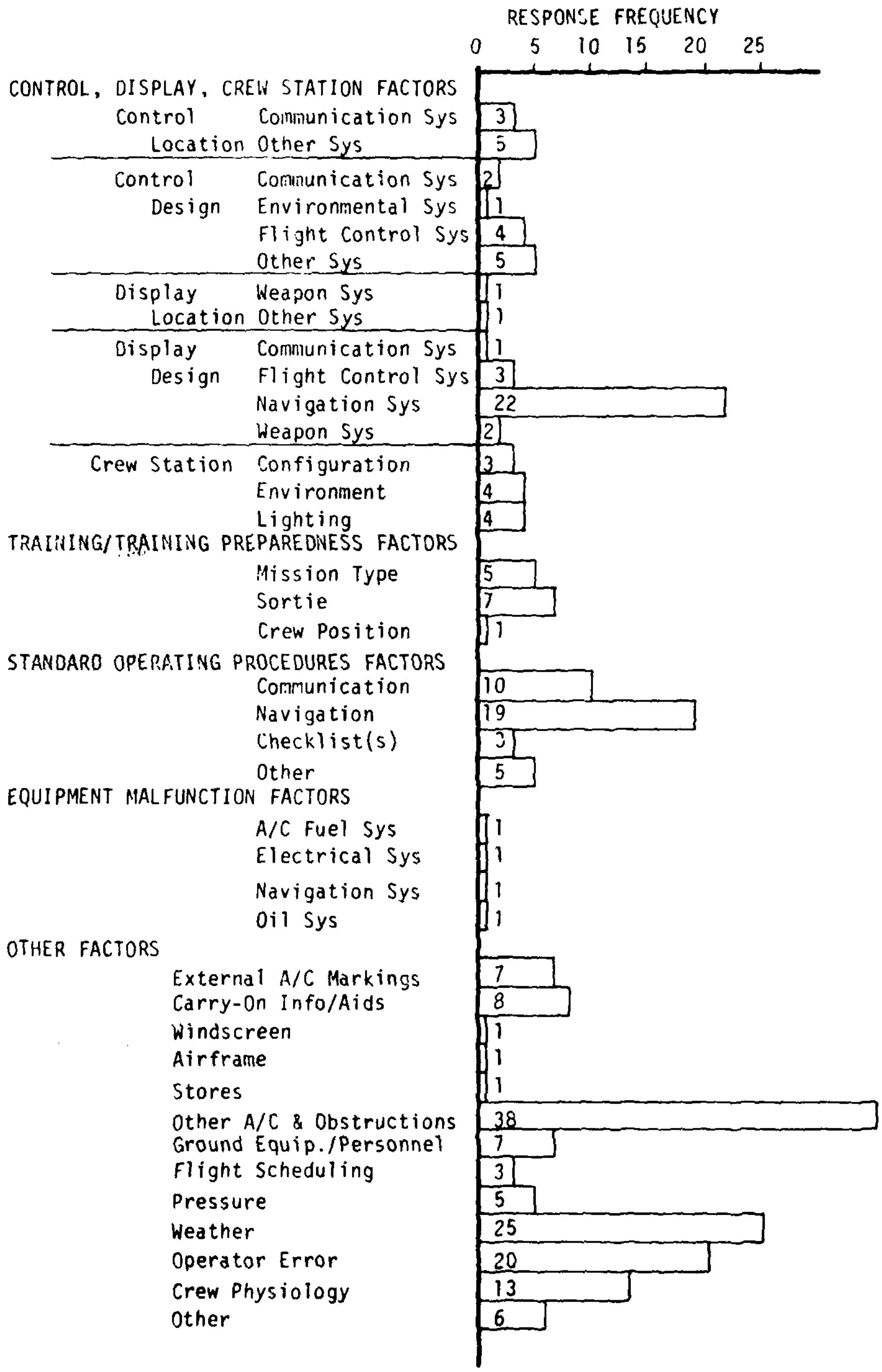

Figure 10. Contributing Causes of High Workload Reported for the A-10A

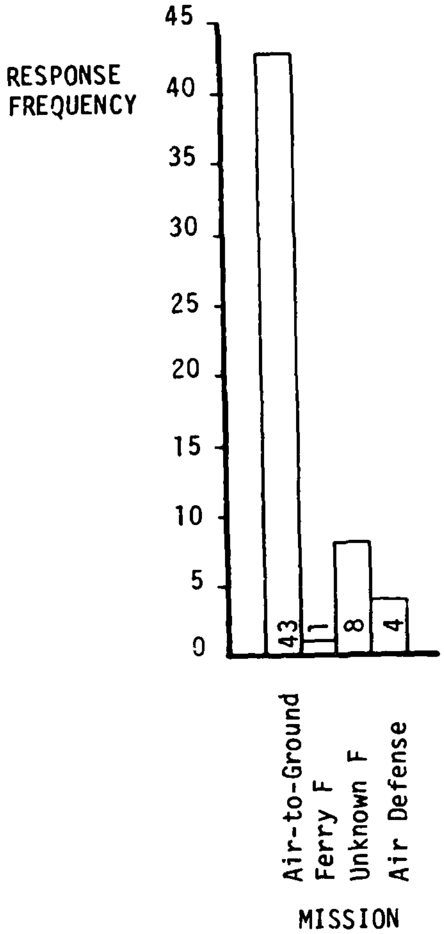

Figure 11. Mission Flown During which High Workload Problems Occurred (n=56)

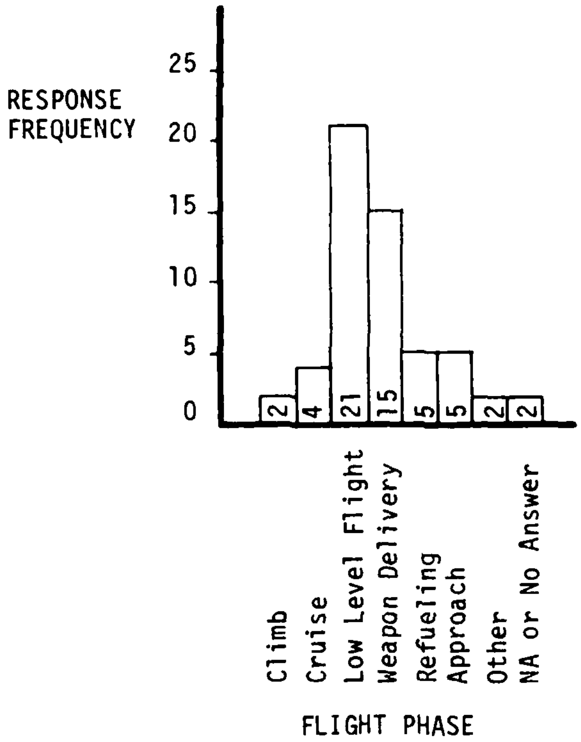

Figure 12. Phase of Flight During which Workload Problems Occurred (n=56)

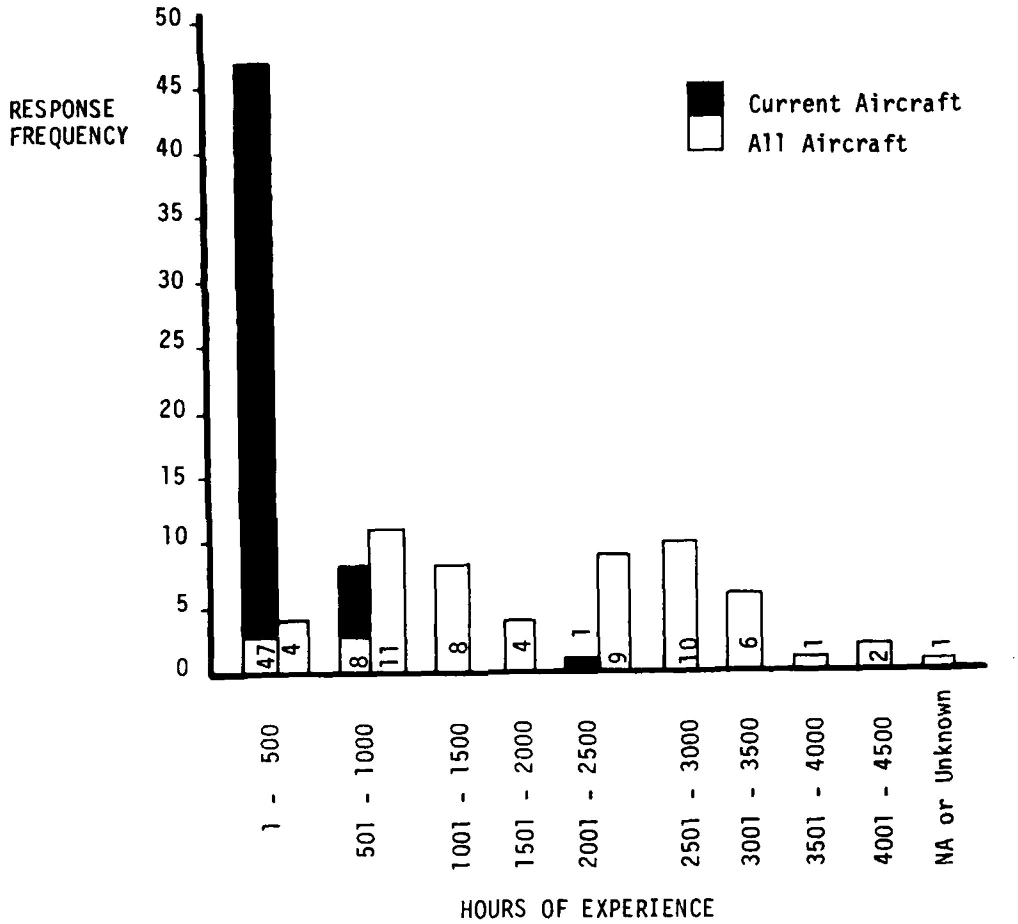

Figure 13. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=56)

b. B-52D, G, H Workload

The necessity for precise coordination of information among crewmembers during the low-level penetration phase of the bombing mission was repeatedly identified as high-workload inducive. Navigation and communication procedures during the penetration phase, along with checklist duties, reportedly contributed to the high workloads of the crewmembers. The data from the survey further identify operator errors as frequently resulting from the necessary coordination required during this high workload situation (low-level penetration), the occurrence of which further compounds the workload level of the pilot and other crewmembers. The pilots also reported that fatigue resulting from long night flights affected landing performance and produced checklist errors (e.g., missed items), both of which the pilots believed created higher workloads at a time when their ability to compensate was degraded. The B-52 pilots attributed the source of this last problem to be related to the frequent requirement of completing a training block after long flights which already extend into the early morning hours.

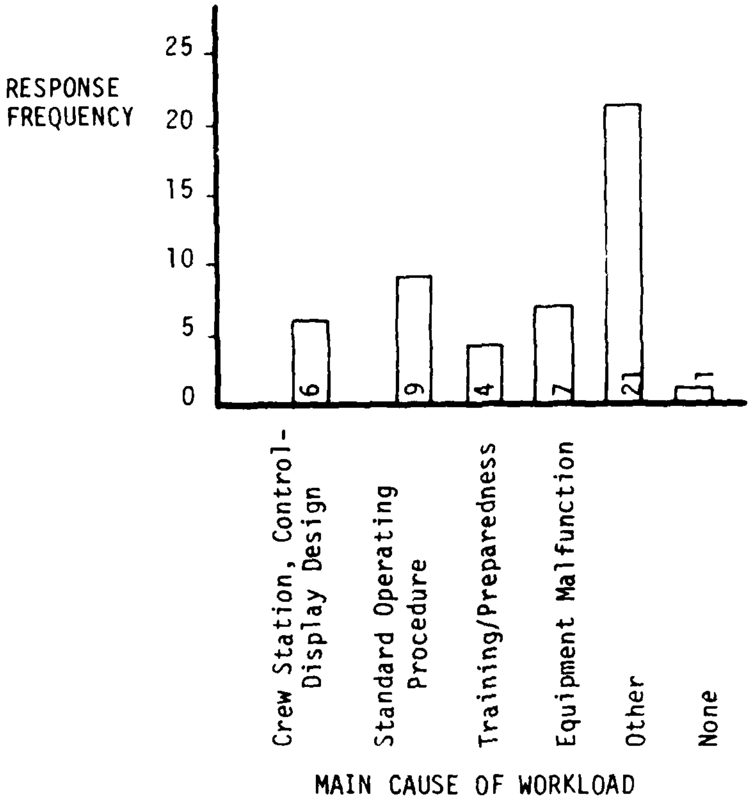

Figure 14. The Main Contributing Causes of Stated Workload Problems for all B-52, B-52D, B-52G, and B-52H Respondents (n=48)

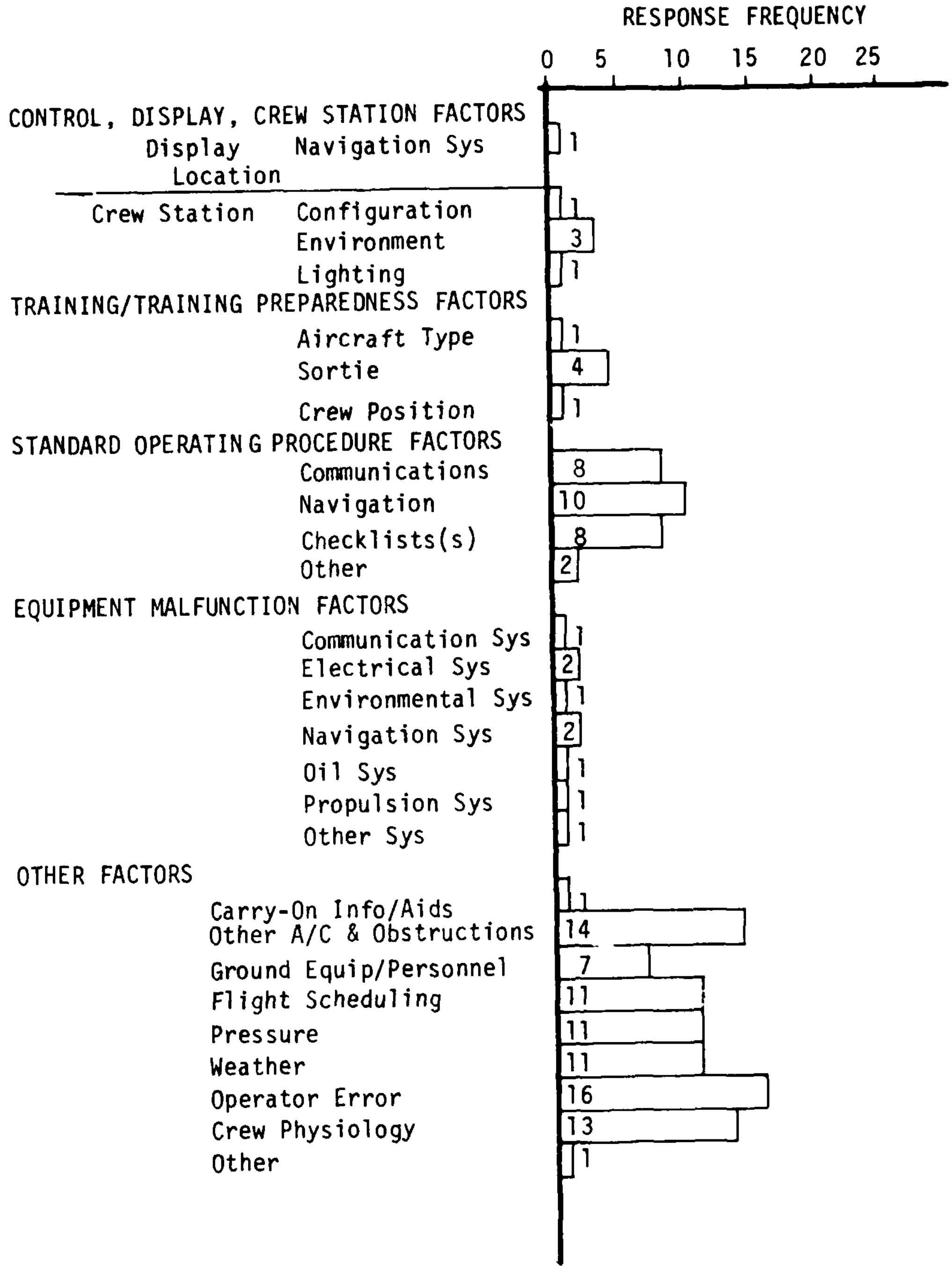

Figure 15. Contributing Causes of High Workload Reported for the B-52, D, G, and H

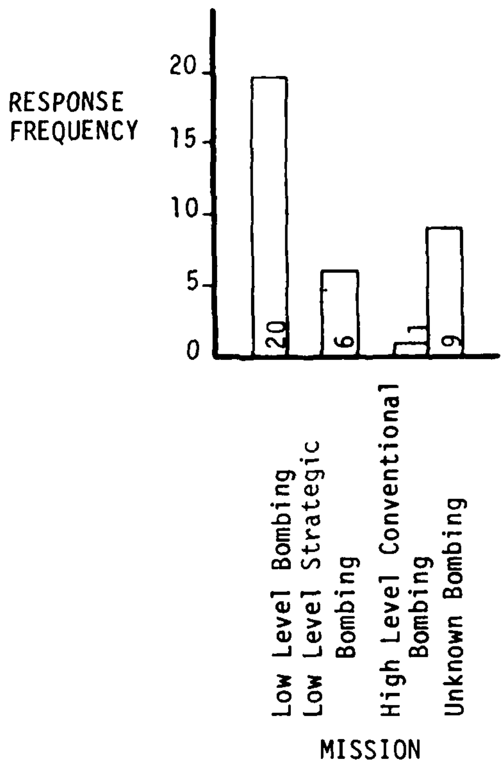

Figure 16. Mission Flown During Which Workload Problems Occurred (n=36)

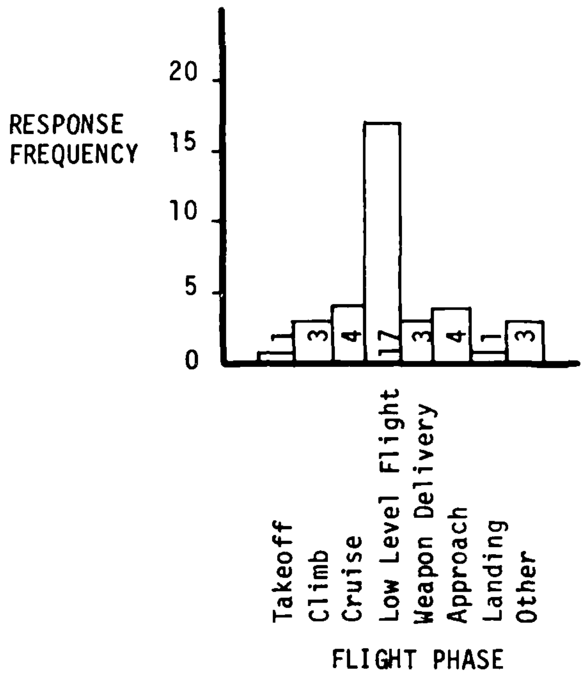

Figure 17. Phase of Flight During Which Workload Problems Occurred (n=36)

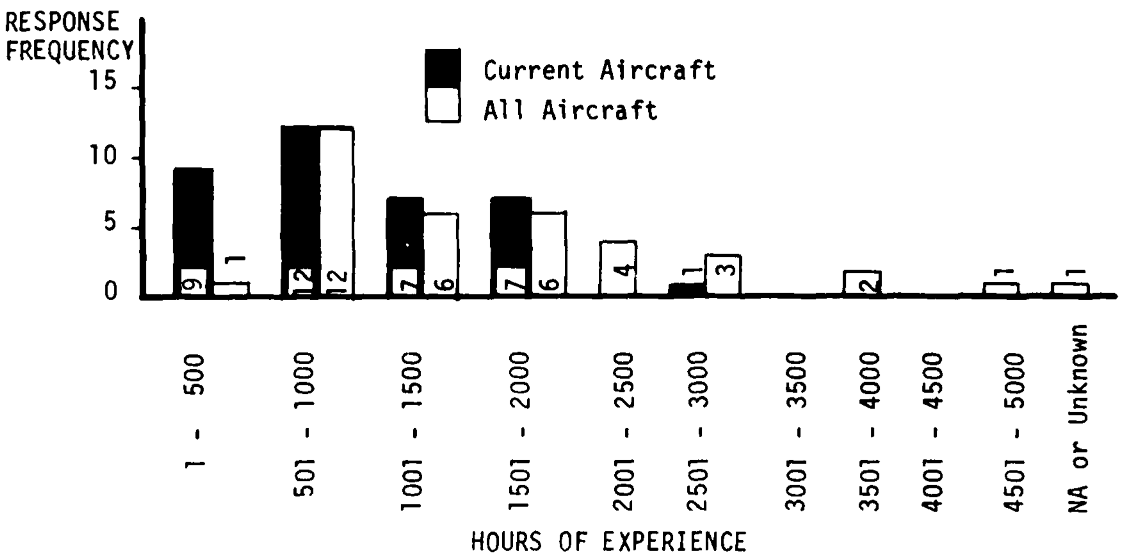

Figure 18. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=36)

c. C-5A Workload

Surveyed pilots reported high workload situations occurring most frequently during the approach to the landing portion of the mission. The reported causes, or contributors to these high workloads were predominantly fatigue and boredom. Fatigue was reported as a significant factor primarily on West-bound flights. The occurrence of fatigue was explained to result from early morning (i.e., 0100, 0200 hours) departures preceded by full working days at the Squadron. Pilots repeatedly reported degraded landing performance resulting from fatigue as the cause of high workloads. The pilots surveyed further explained that the crew-rest at intermediate stops was typically scheduled between 0800 and 1600 hours local time, which did not facilitate thorough, needed crew-rest.

The pilots also reported that the long period of low activity (i.e., cruise) usually was concluded with a period of high activity. The reported result was missed checklist items during descent from cruise altitude and approach to landing.

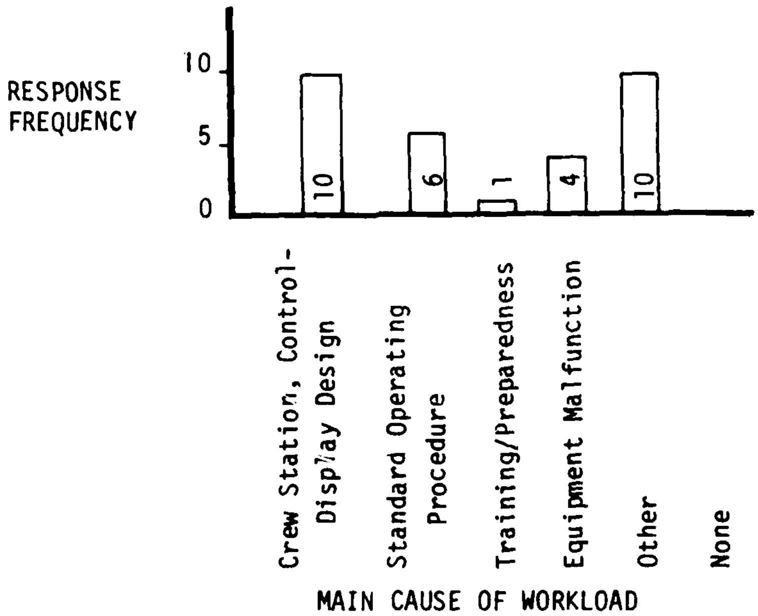

Figure 19. The Main Contributing Causes of Stated Workload Problems for all C-5A Respondents (n=31)

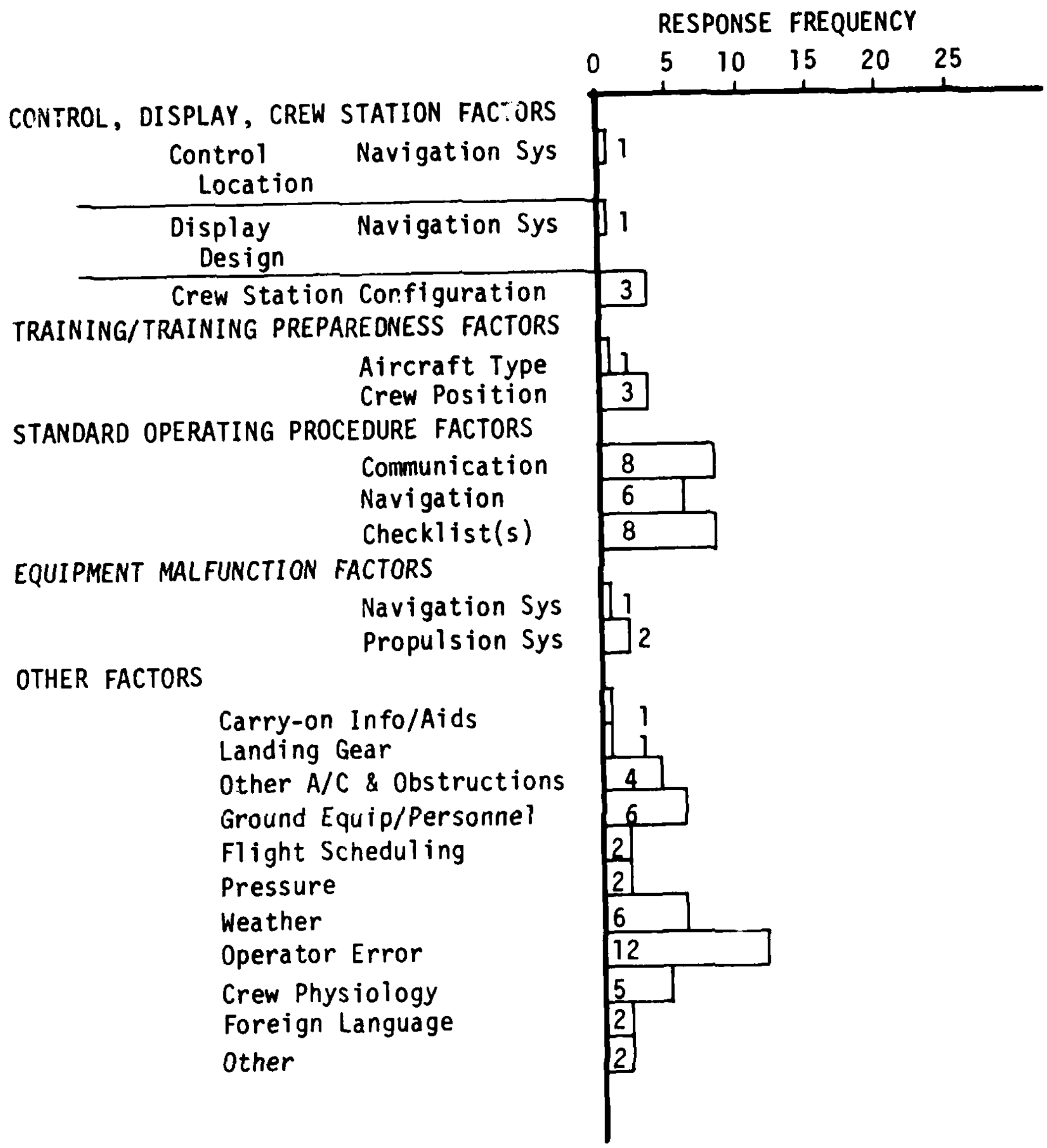

Figure 20. Contributing Causes of High Workload Reported for the C-5A

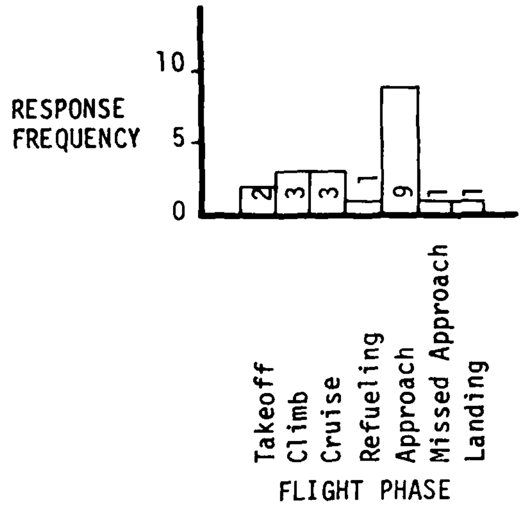

Figure 21. Phase of Flight During Which Workload Problems Occurred (n=20)

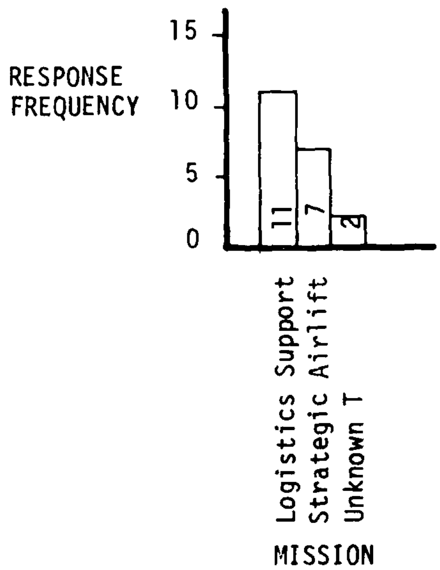

Figure 22. Mission Flown During Which Workload Problems Occurred (n=20)

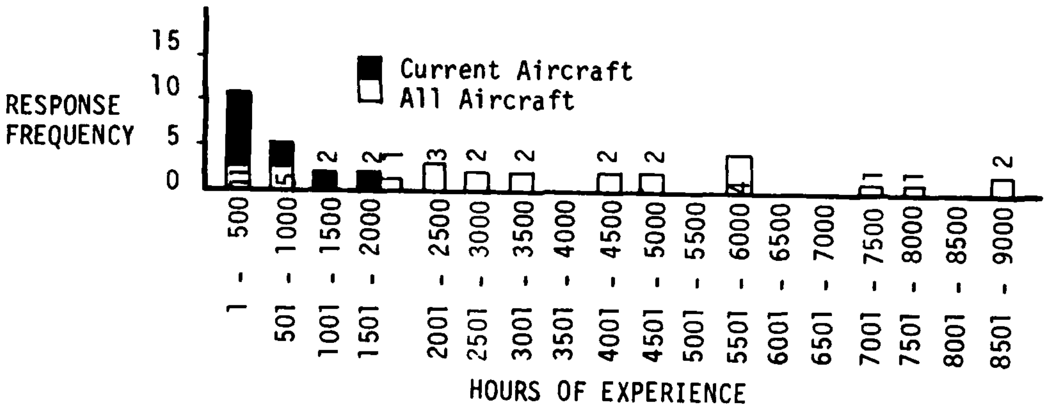

Figure 23. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=20)

d. C-130 Workload

This survey disclosed a variety of high workload situations evolving around the use of the Station Keeping Equipment (SKE) in IFR weather conditions. Pilots frequently described procedural breakdowns in crew procedures, checklists, and station keeping accuracy as the drop-zone approached. The occurrence of more frequent checklists, needed AWADS (Adverse Weather Aerial Delivery System) information, and the location of the SKE displays were all reported as specific contributors to the high workloads preceding an air drop.

Pilots also reported that their workload when flying the lead aircraft of a formation drop was increased due to the additional procedures the lead aircraft crew must accomplish, such as obtaining clearance from the drop-zone.

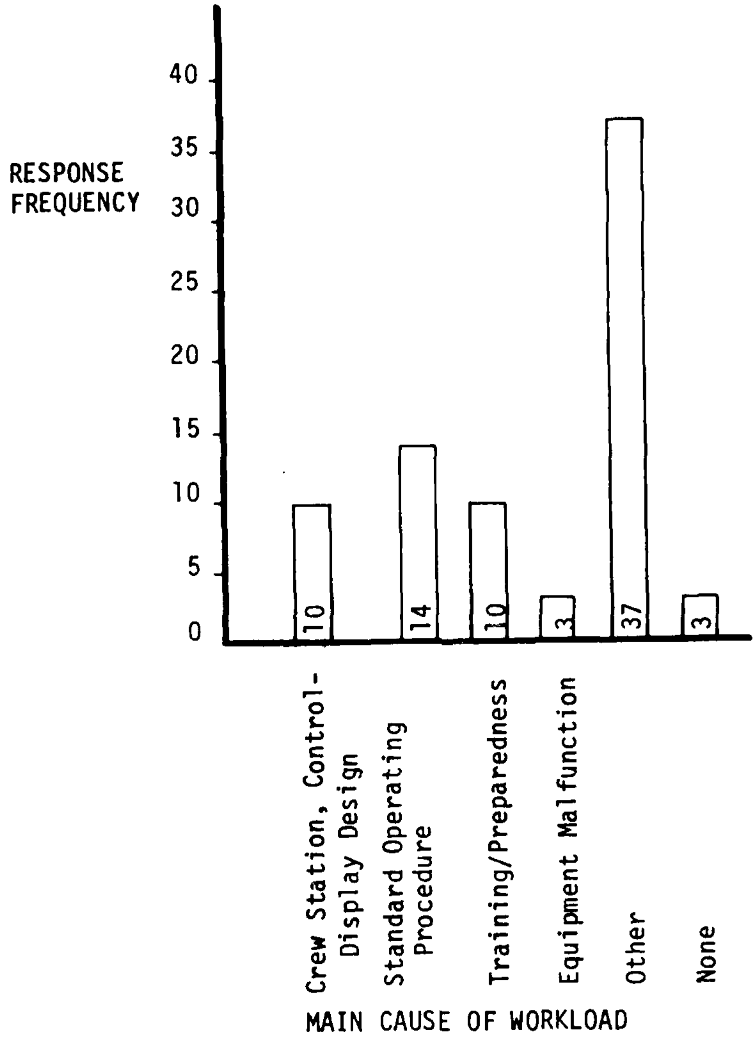

Figure 24. The Main Contributing Causes of Stated Workload Problems for all C-130 and C-130E Respondents (n=77)

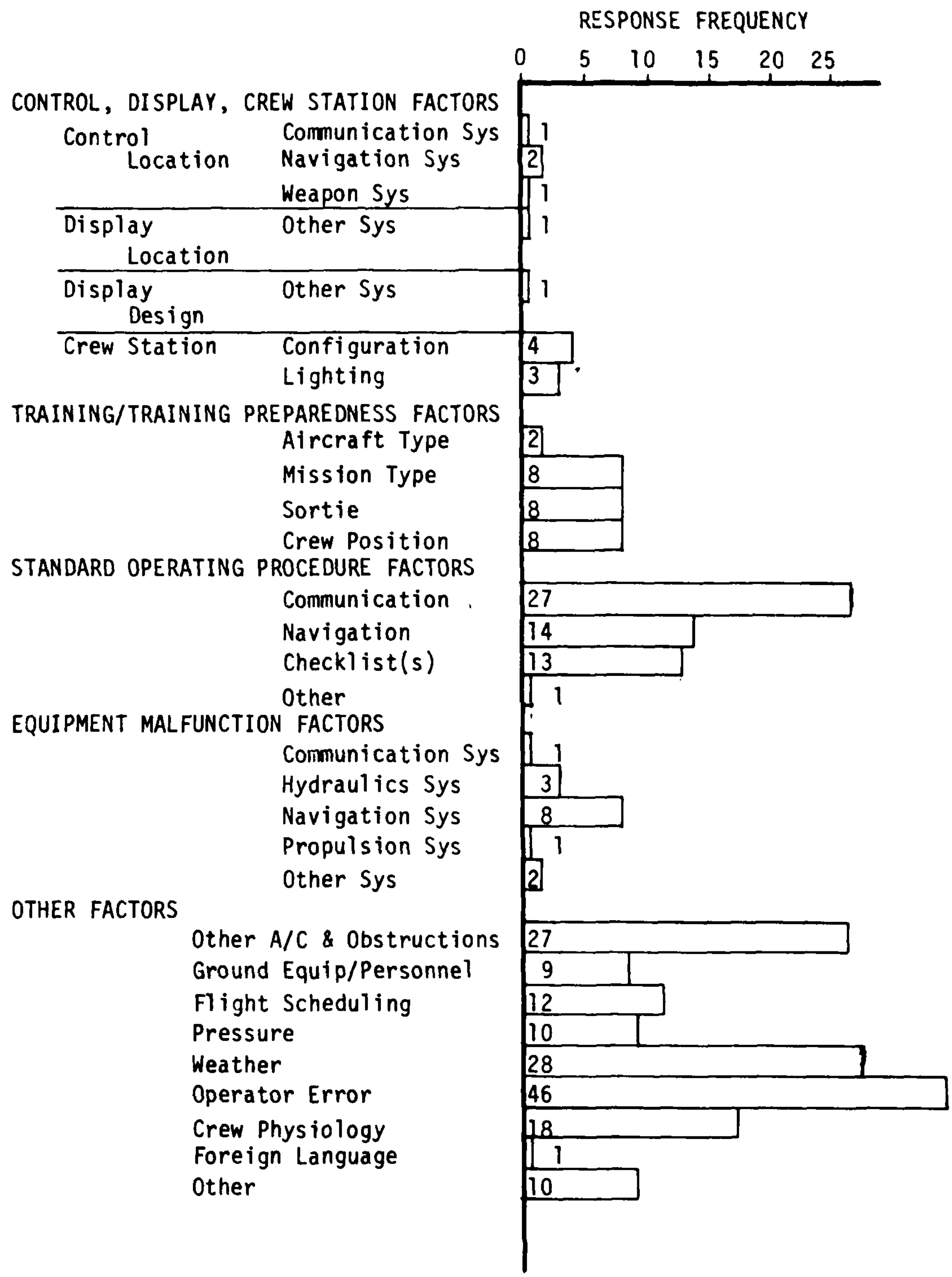

Figure 25. Contributing Causes of High Workload Reported for the C-130, E

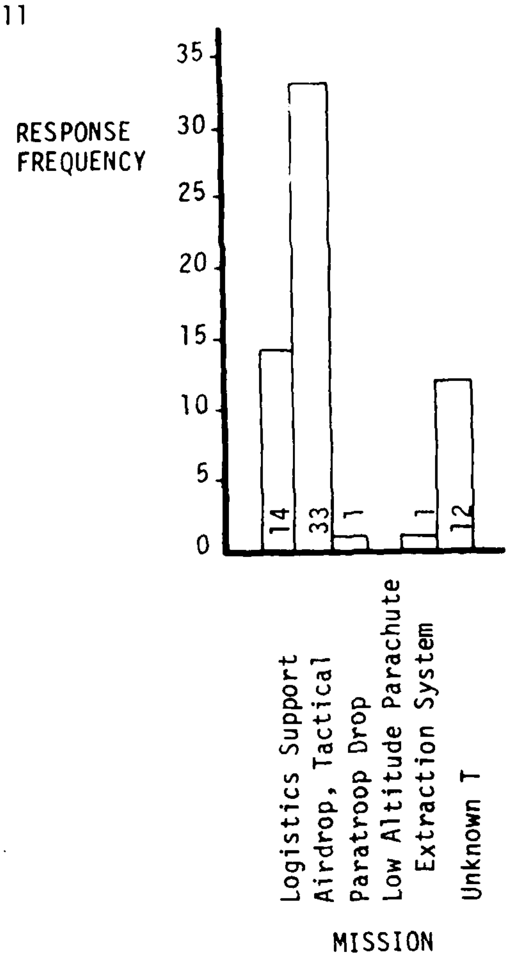

Figure 26. Mission Flown During Workload Problems Occurred (n=61)

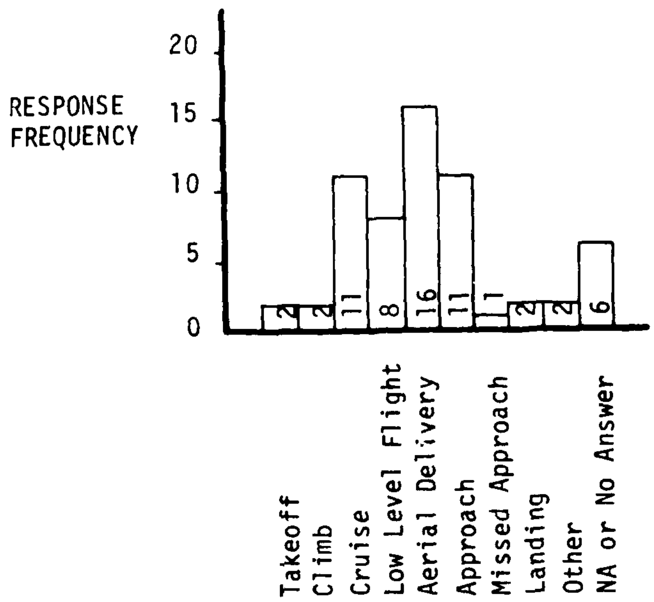

Figure 27. Phase of Flight During Which Workload Problems Occurred (n=61)

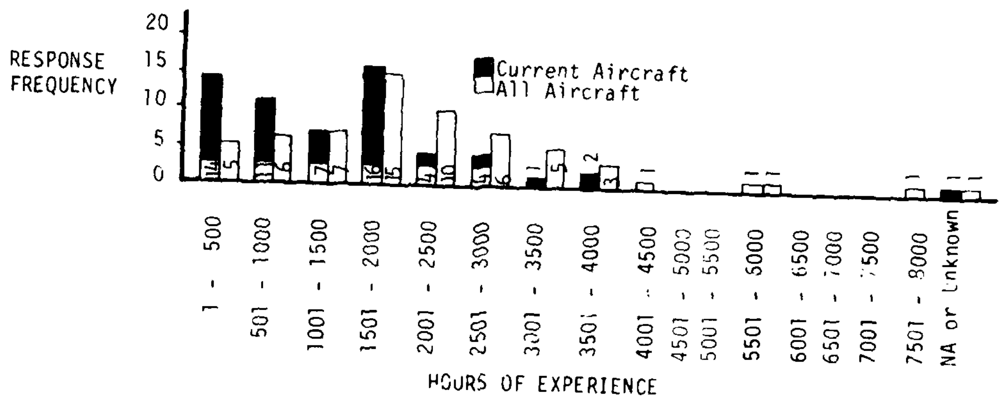

Figure 28. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=61)

e. C-141A Workload

High workload situations were reported to frequently occur during approaches to landing which involved weather avoidance. The reported use of the radar display for weather avoidance requires adjustment of the CRT on the pilot's panel using controls that are located at the navigator's station. Without a navigator, however, the adjustment is left to the pilot or copilot and results in distraction from the task of flying the aircraft, communicating, and accomplishing checklists.

Pilots also reported that operator errors and other procedural breakdowns resulting from long, fatigue-producing flights created high workload situations. The pilots related this fatigue to flying schedules that were driven by the local time of arrival at the destination, rather than by the crew's duty day or local time of departure. Such scheduling reportedly required departures of long flights to occur primarily in the evening or early morning.

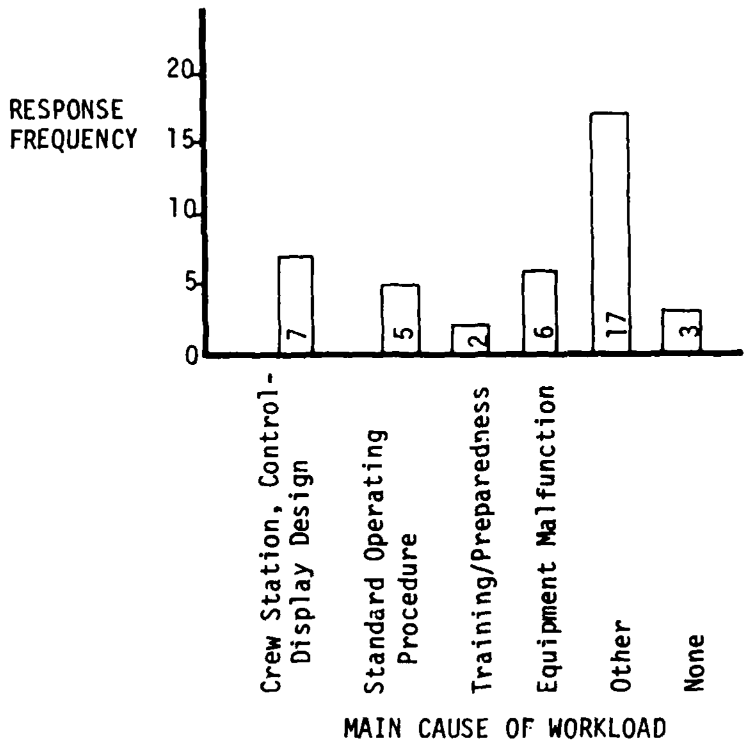

Figure 29. The Main Contributing Causes of Stated Workload Problems for all C-141A Respondents (n=40)

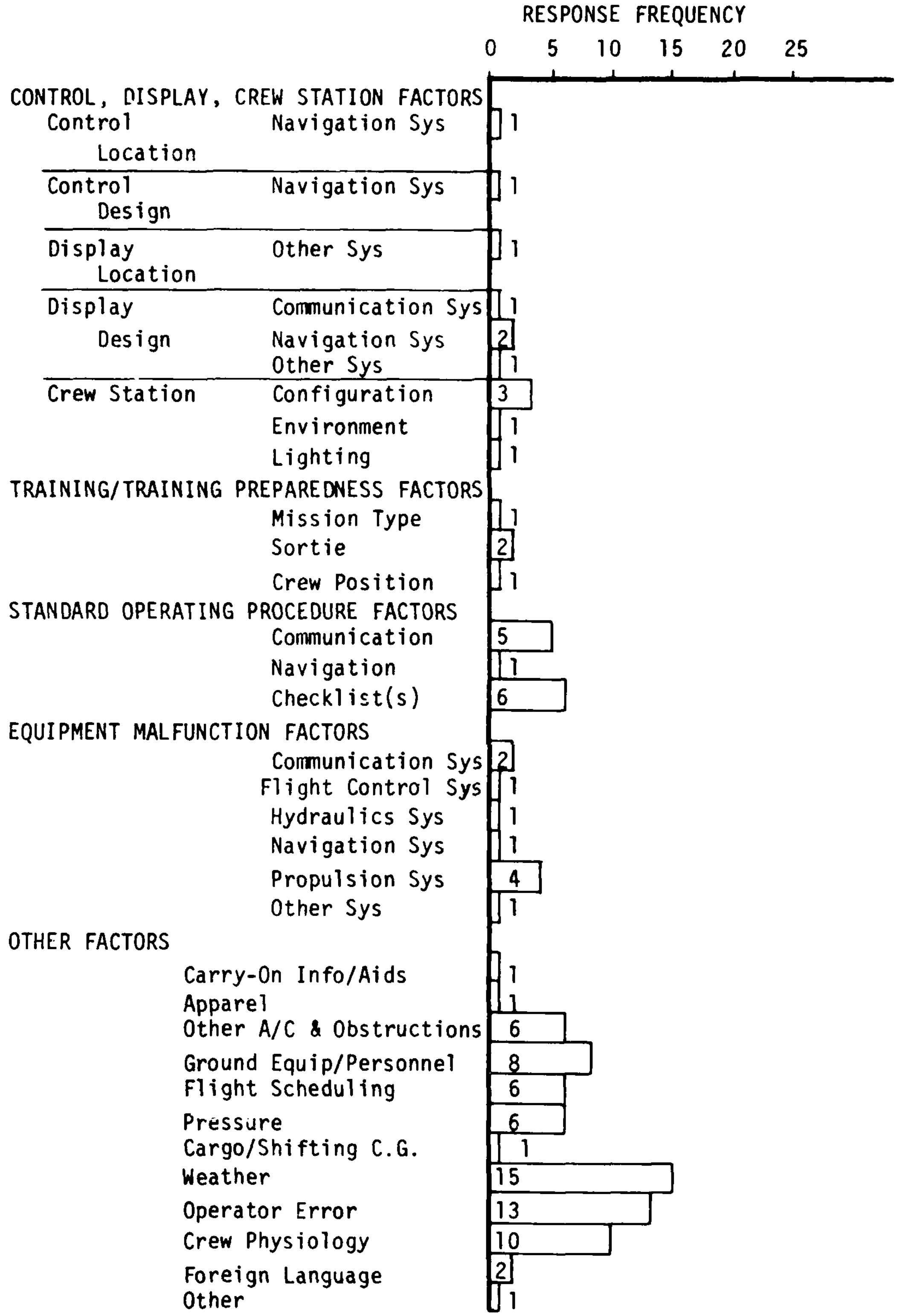

Figure 30. Contributing Factors of High Workload Reported for the C-141A

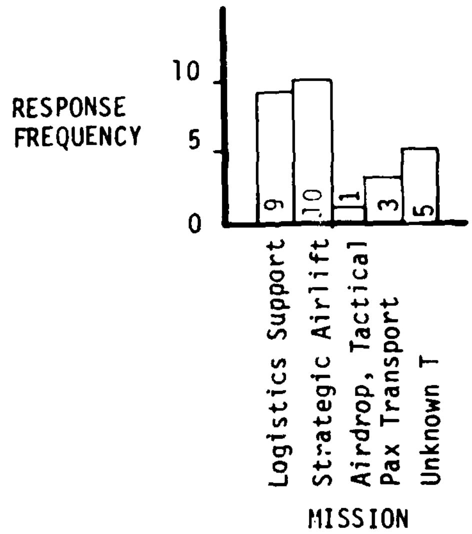

Figure 31. Mission Flown During Which Workload Problems Occurred (n=28)

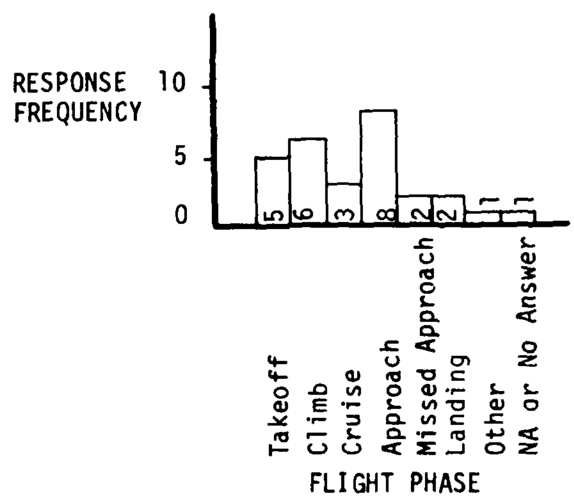

Figure 32. Phase of Flight During Which Workload Problems Occurred (n=28)

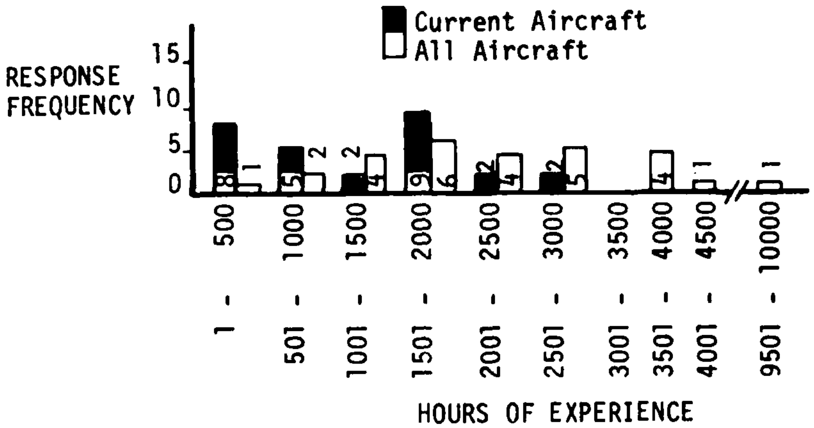

Figure 33. Number of Hours of Prior Flying Experience in (a) Current Aircraft and (b) all Aircraft Type (n=28)

f. E-3A Workload

Pilots of the E-3A reported high workloads associated with takeoff and landing data recomputations just prior to takeoff. Such recomputations were necessitated by weather and/or runway changes occurring after initial computation and taxiing to the number one position for takeoff clearance. The reported problem is not that the changes were untimely, but rather the recomputation was cumbersome, requiring the use of graphs in the Technical Order (Dash One) Document. The pilots reportedly felt pressured to maintain the takeoff schedule rather than accept a takeoff delay, which resulted in their hurrying through the recomputation to avoid the use of incomplete or inappropriate takeoff data. In their survey responses, however, the pilots indicated a recognition of the increased potential for computation errors resulting from their hurried procedure, which could further compound the workload of the original situation.

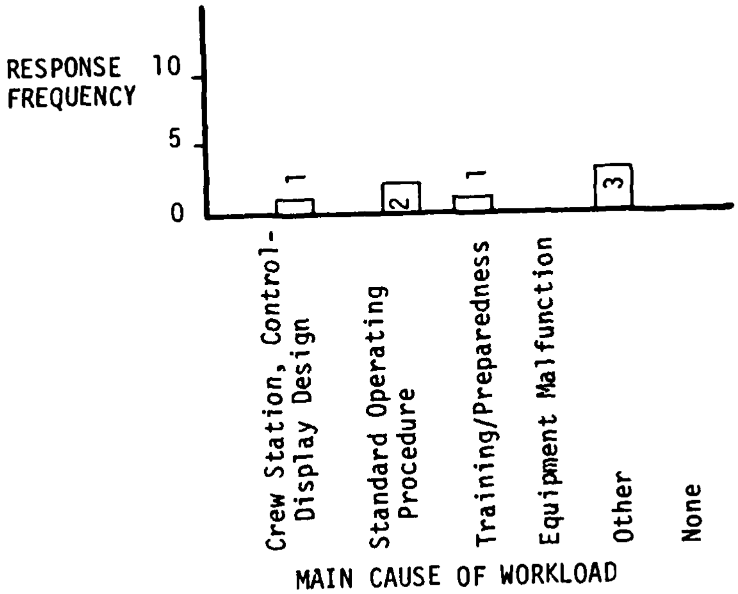

Figure 34. The Main Contributing Causes of Stated Workload Problems for all E-3A Respondents (n=7)

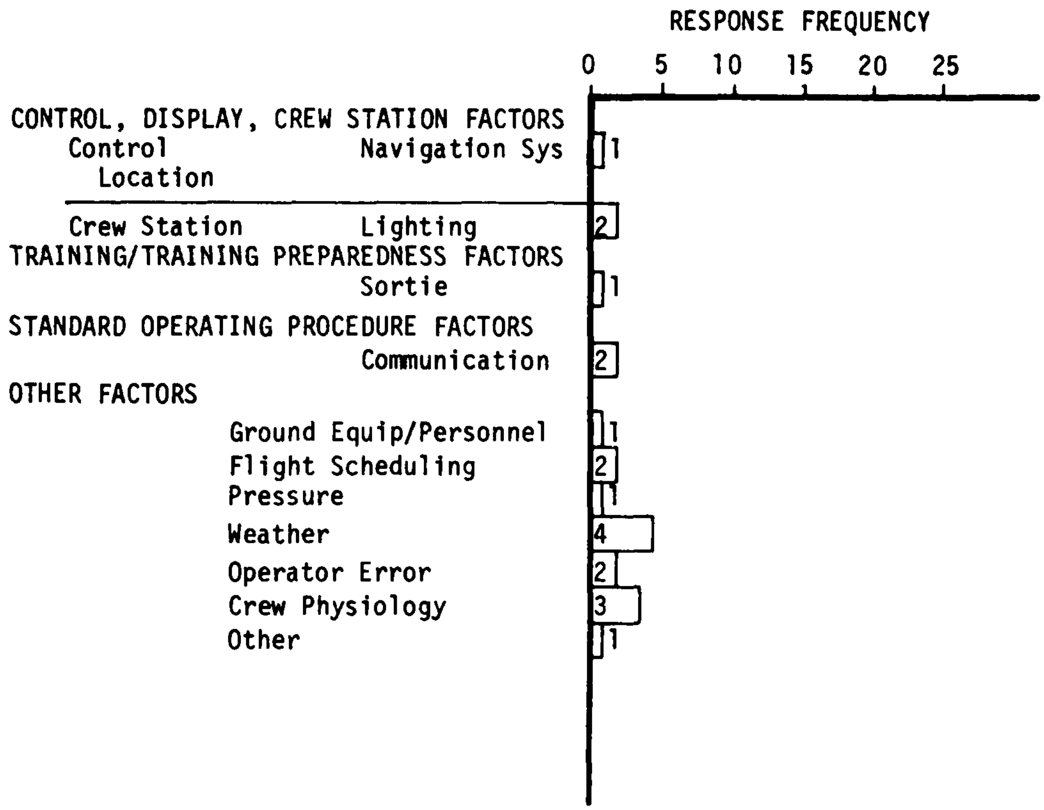

Figure 35. Contributing Factors of High Workload Reported for the E-3A

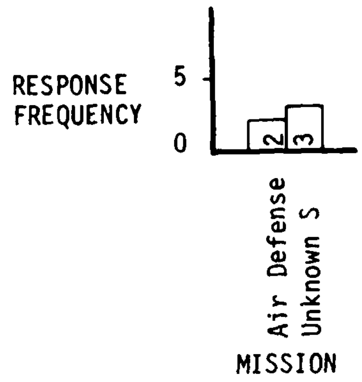

Figure 36. Mission Flown During Which Workload Problems Occurred (n=5)

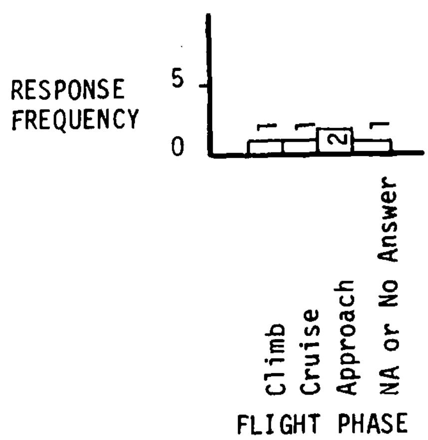

Figure 37. Phase of Flight During Which Workload Problems Occurred (n=5)

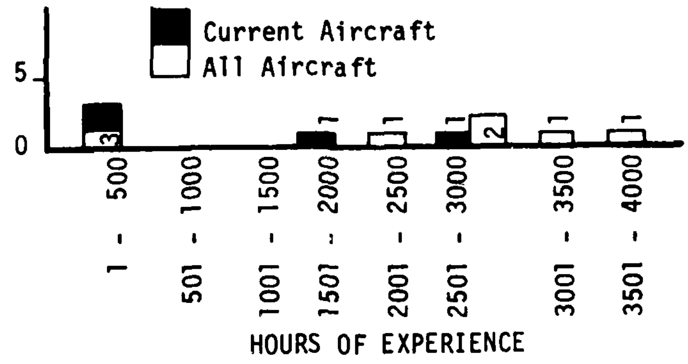

Figure 38. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=5)

g. EC-135 Workload

Pilots of the EC-135 reported high workloads resulting from the same situation as described for the E-3A.

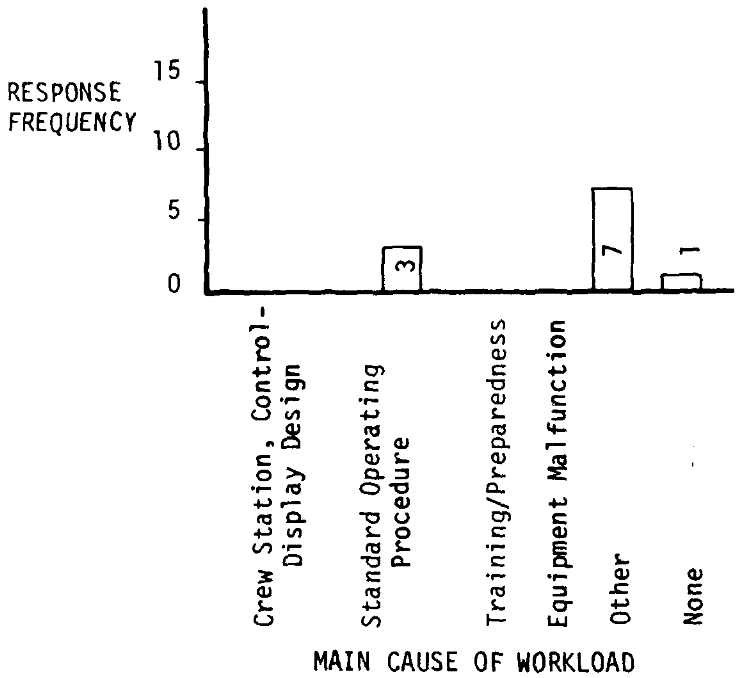

Figure 39. The Main Contributing Causes of Stated Workload Problems for all EC-135 Respondents (n=11)

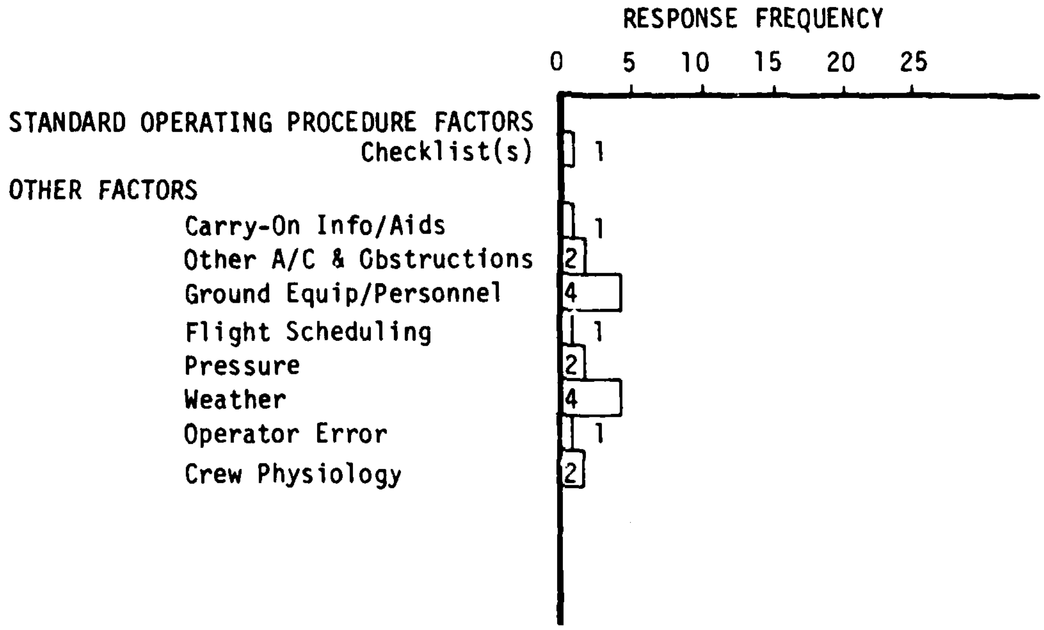

Figure 40. Contributing Factors of High Workload Reported for the EC-135

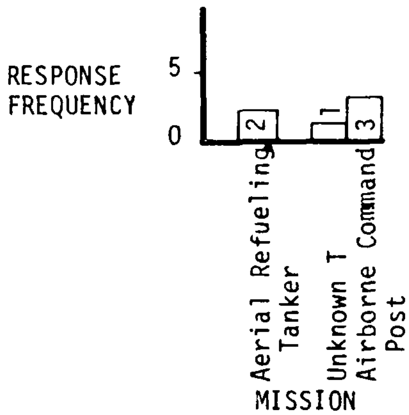

Figure 41. Mission Flown During Which Workload Problems Occurred (n=6)

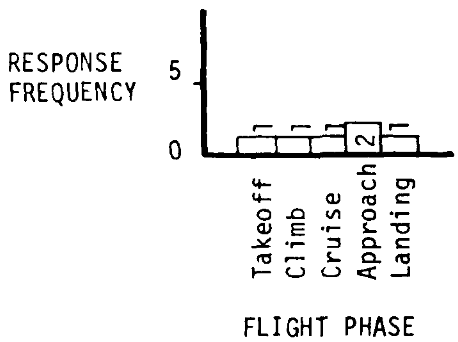

Figure 42. Phase of Flight During Which Workload Problems Occurred (n=6)

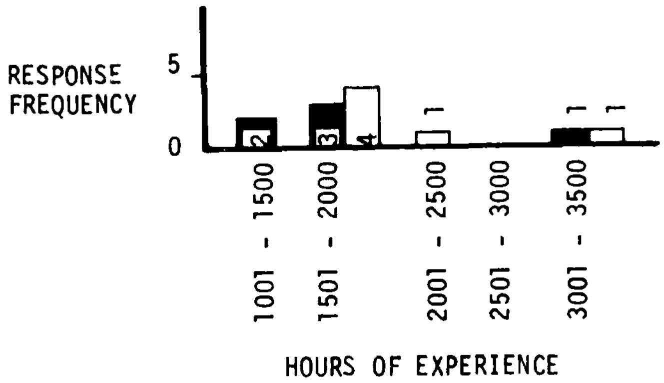

Figure 43. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=6)

h. F-4, D, E, F, G Workload

High workload situations reported by surveyed pilots evolved around the low-level penetration phase of the air-to-ground mission. Pilots reported that subsystem malfunctions (e.g., communication or environmental) and/or normal mission procedures, such as communication and navigation tasks, occurring during this phase of the mission frequently resulted in operator errors. And, as would be expected, the pilots reported that the addition of weather factors further increased workload. It was also reported by the pilots that pressure to maintain scheduled target arrival times frequently contributed further anxiety to an already difficult situation.

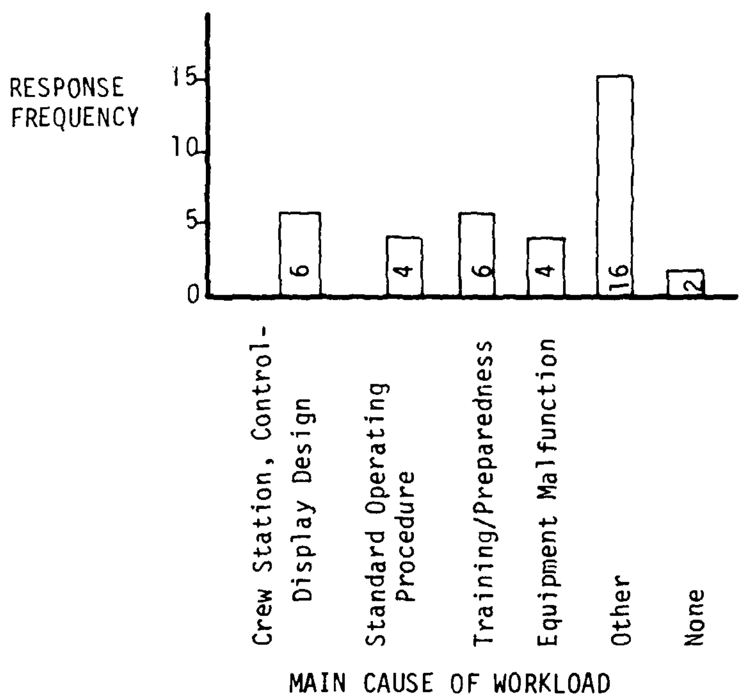

Figure 44. The Main Contributing Causes of Stated Workload Problems for all F-4, F-4D, F-4E, and F-4G Respondents (n=38)

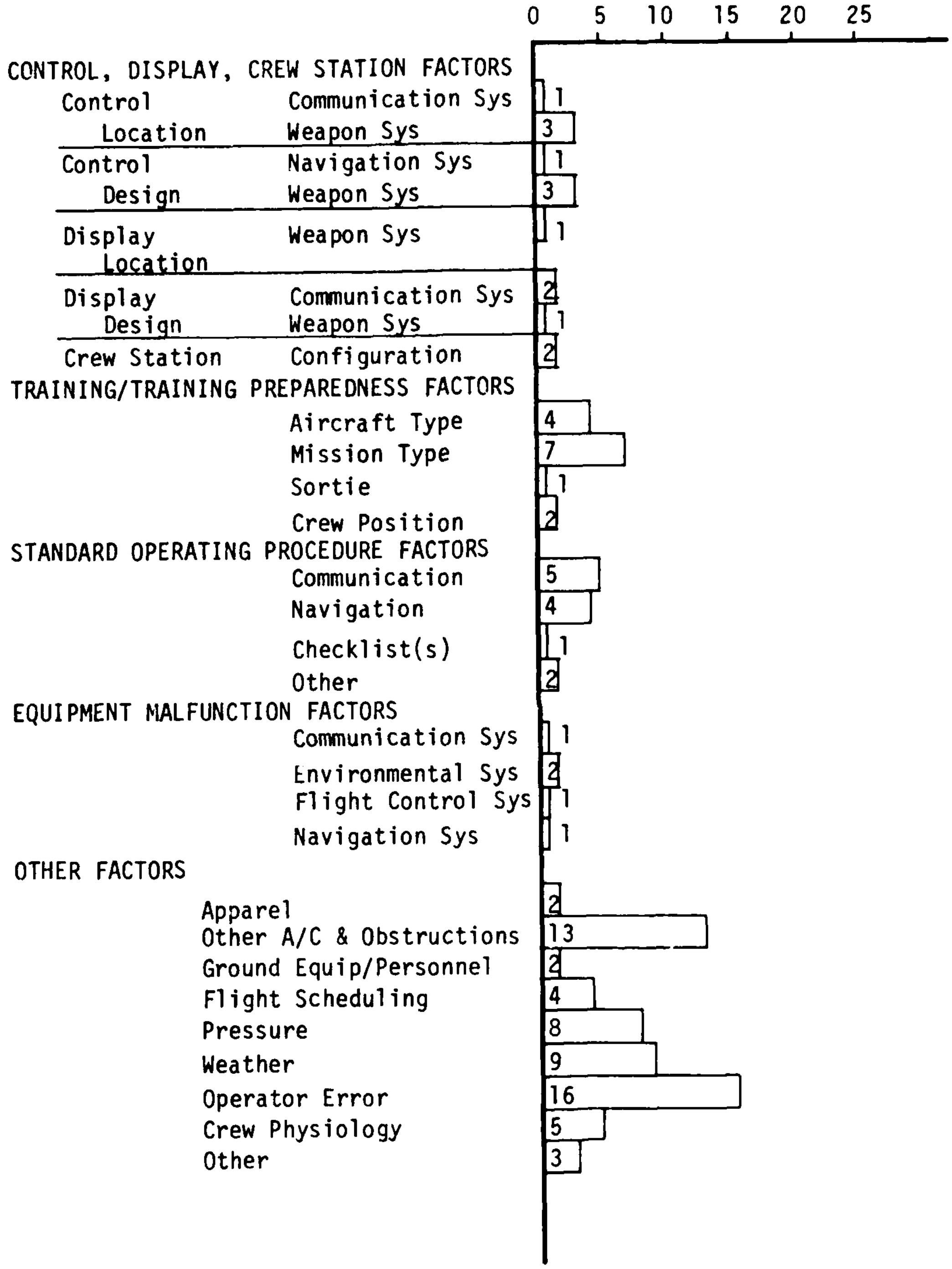

Figure 45. Contributing Factors of High Workload Reported for the F-4, D, E, G

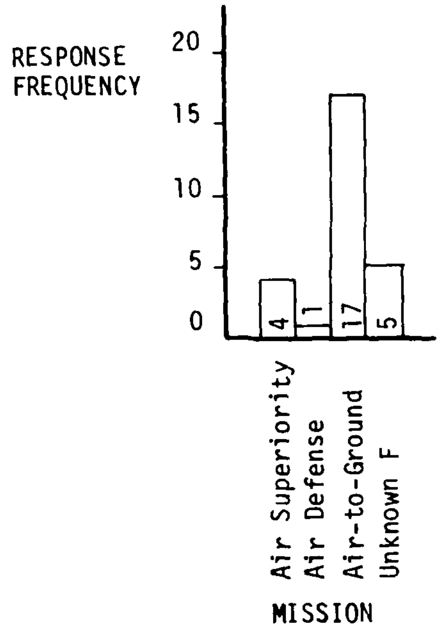

Figure 46. Mission Flown During Which Workload Problems Occurred (n=27)

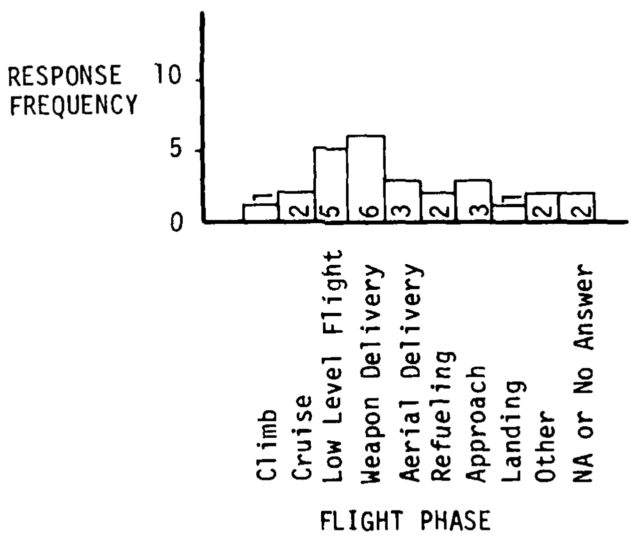

Figure 47. Phase of Flight During Which Workload Problems Occurred (n=27)

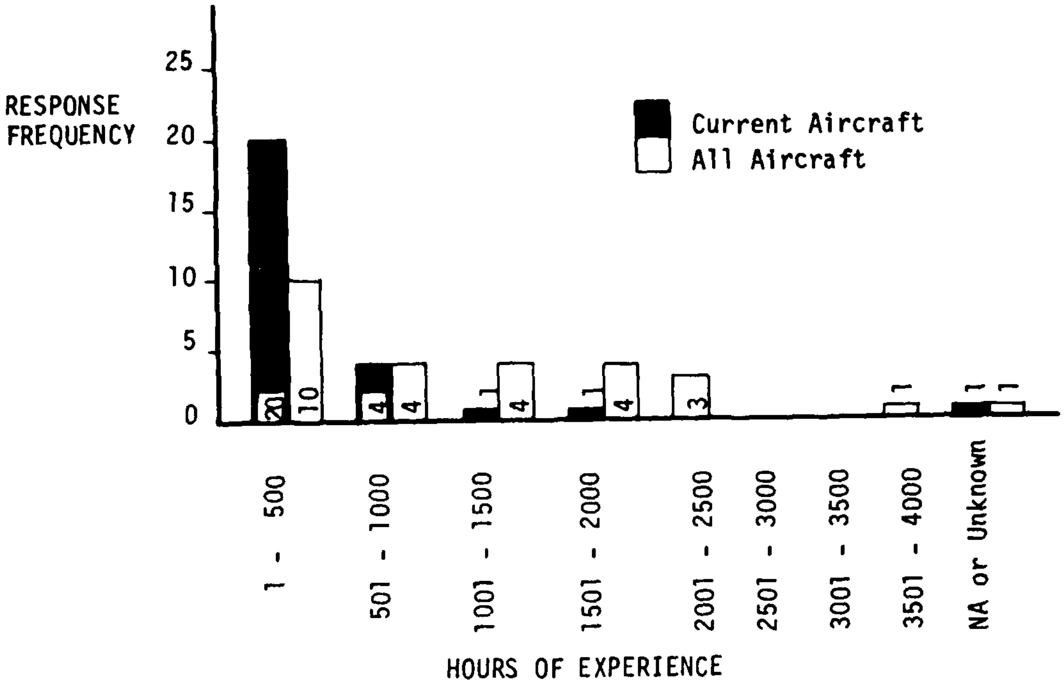

Figure 48. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=27)

i. F-5E Workload

The F-5E was generally reported as a very simple aircraft to operate in the air superiority mission. However, the pilots surveyed did express concern over workload resulting from approaches to landing while in weather. The primary concern was the lack of any instrument landing system (ILS) in combination with a poor rain removal system for the windscreen. Also, pilots reported that landing in weather often required head-up viewing of the approach through the sides of the canopy due to poor visibility through the forward windscreen. The pilots indicated that the result of an approach to landing under such circumstances was both higher workload and degraded landing performance.

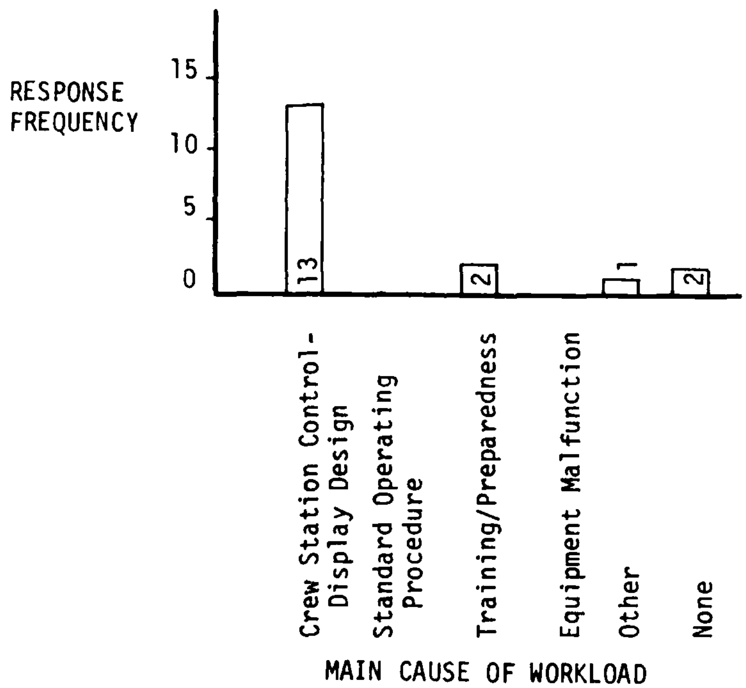

Figure 49. The Main Contributing Causes of Stated Workload Problems for all F-5E Respondents (n=18)

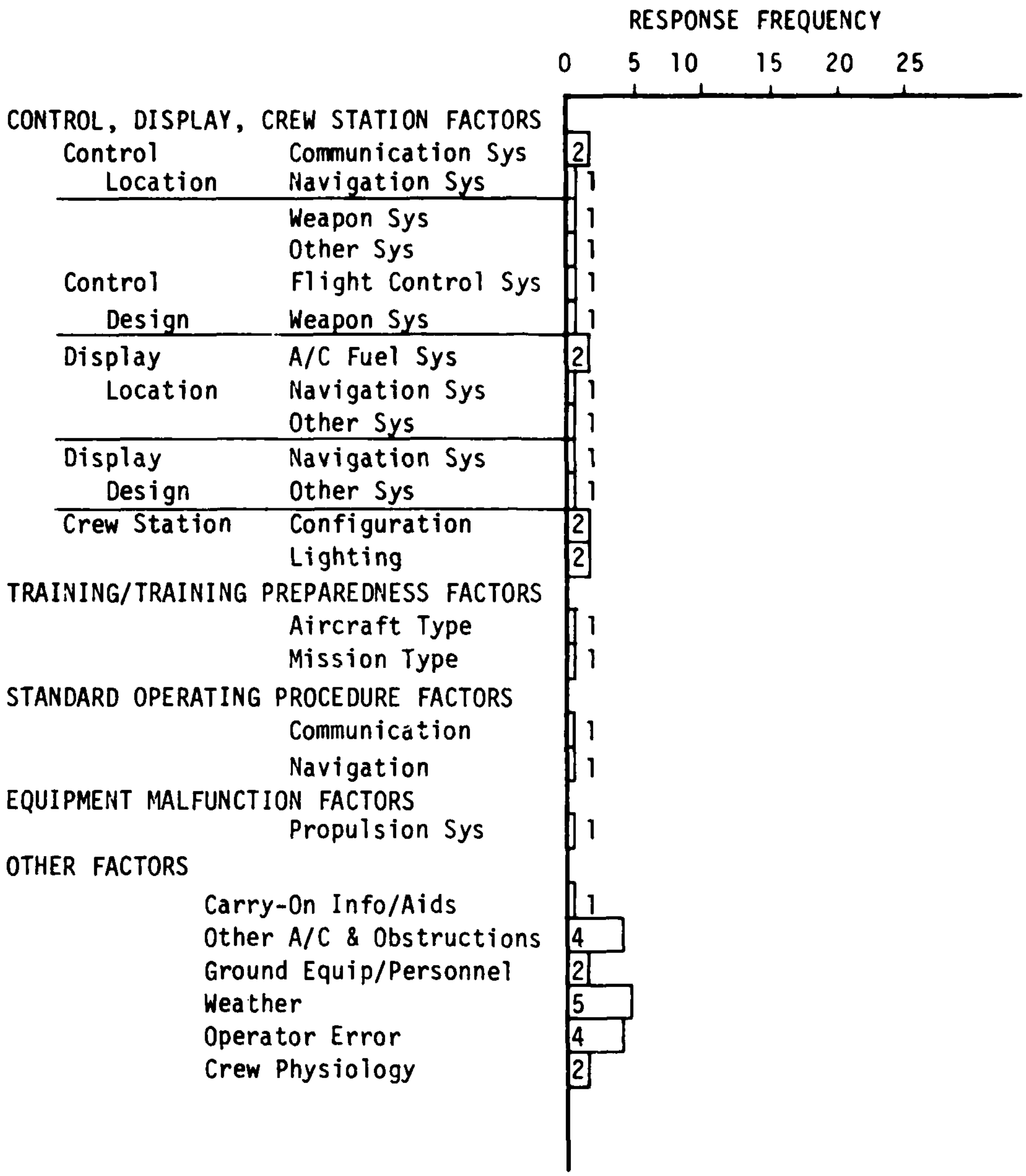

Figure 50. Contributing Factors of High Workload Reported for the F-5E

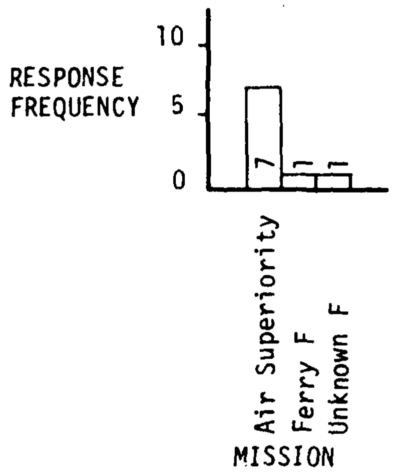

Figure 51. Mission Flown During Which Workload Problems Occurred (n=9)

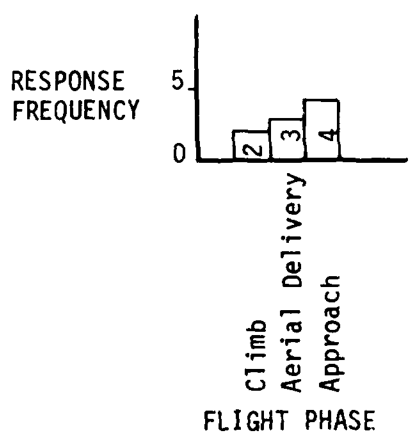

Figure 52. Phase of Flight During Which Workload Problems Occurred (n=9)

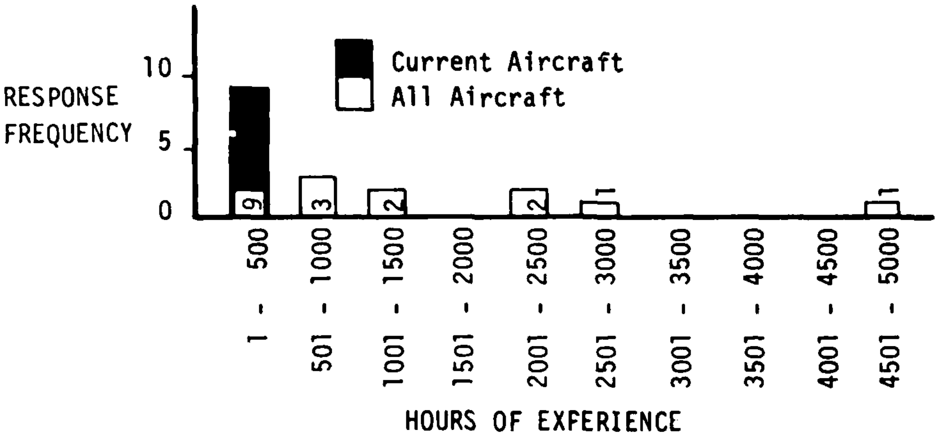

Figure 53. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft

j. F-15A Workload

Surveyed pilots frequently reported high workloads during the aerial delivery phase of the air superiority mission. Pilots reported that spatial disorientation frequently accompanied the use of the radar display and that the resulting degraded performance required higher workloads to compensate.

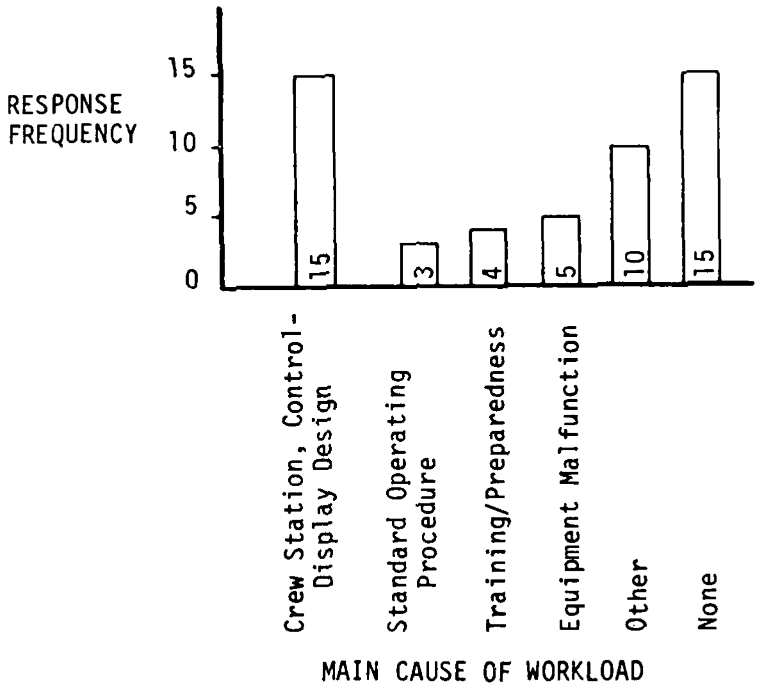

Figure 54. The Main Contributing Causes of Stated Workload Problems for all F-15A Respondents (n=52)

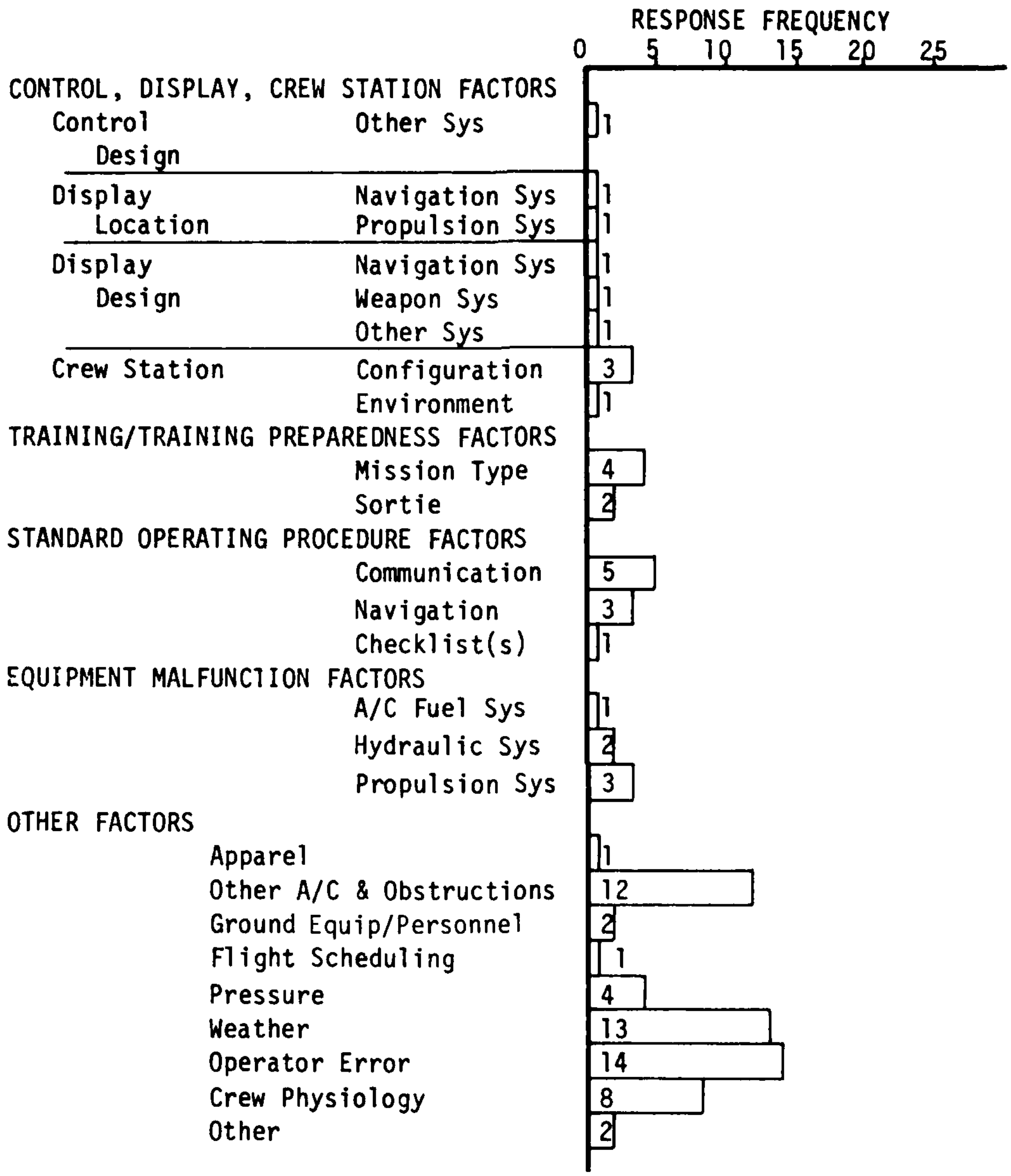

Figure 55. Contributing Factors of High Workload Reported for the F-15A

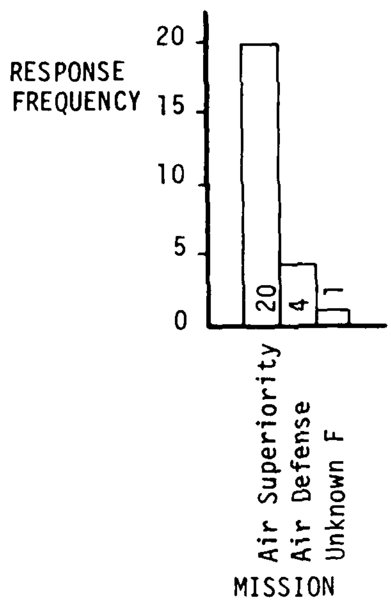

Figure 56. Mission Flown During Which Workload Problems Occurred (n=25)

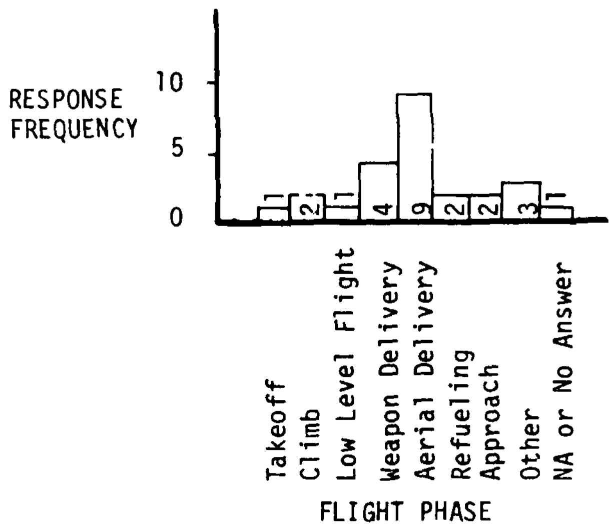

Figure 57. Phase of Flight During Which Workload Problems Occurred (n=25)

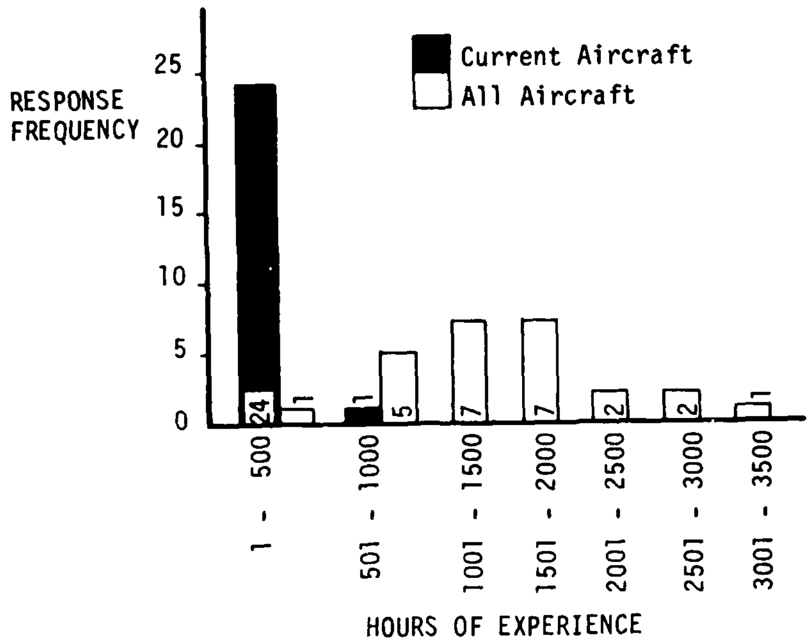

Figure 58. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=25)

k. F-16A Workload

Surveyed pilots responded that operator errors resulting from present levels of familiarity with the aircraft, the crew station equipment, and the crew station configuration were the primary contributors of high workload. Pilots associated this problem with the low-level penetration and weapon delivery phases of their bombing mission.

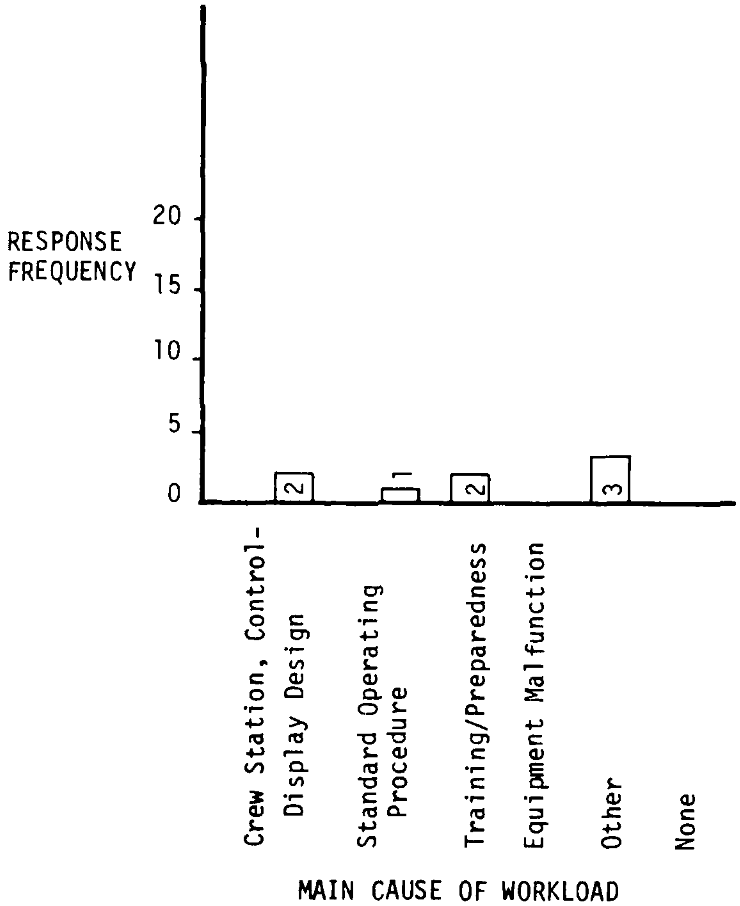

Figure 59. The Main Contributing Causes of Stated Workload Problems for all F-16, F-16A, and F-16B Respondents (n=8)

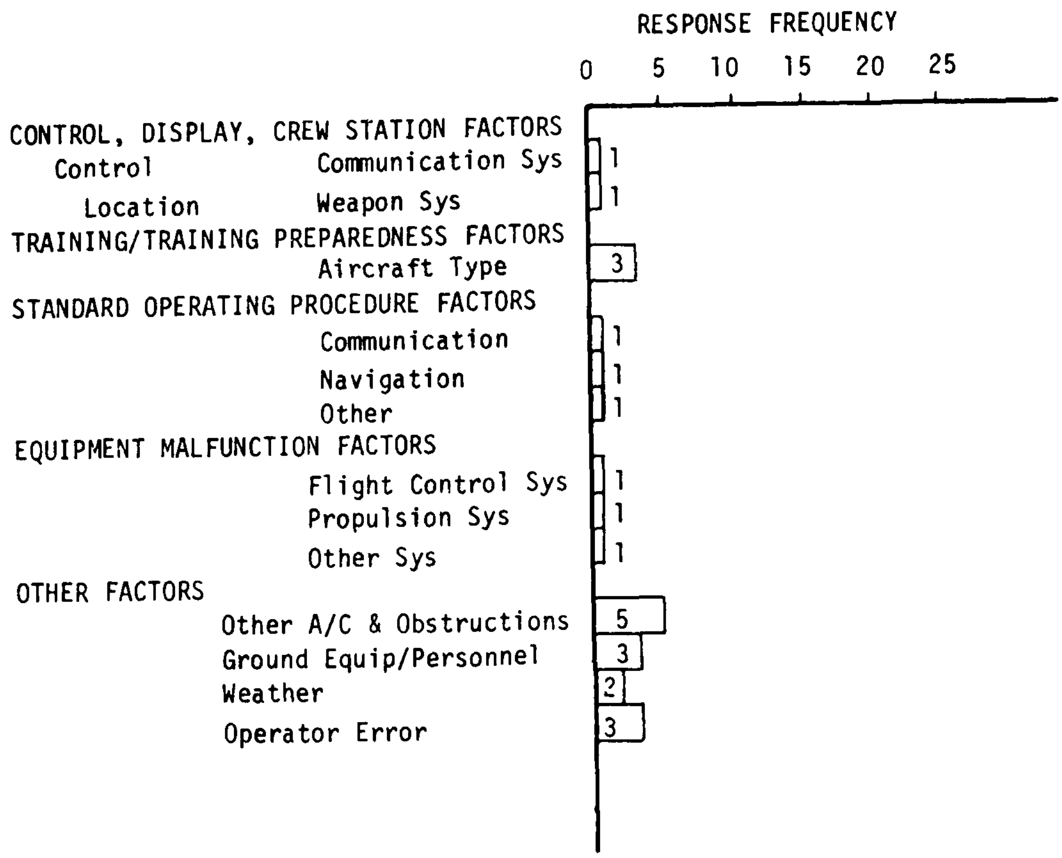

Figure 60. Contributing Factors of High Workload Reported for the F-16A, B

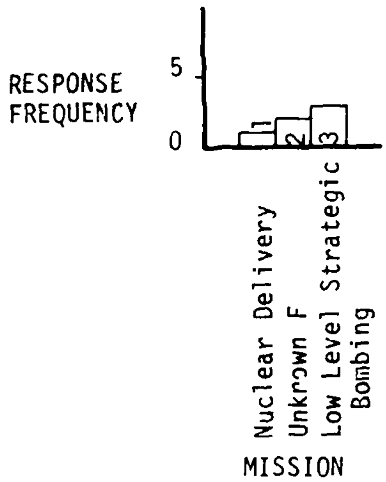

Figure 61. Mission Flown During Which Workload Problems Occurred (n=6)

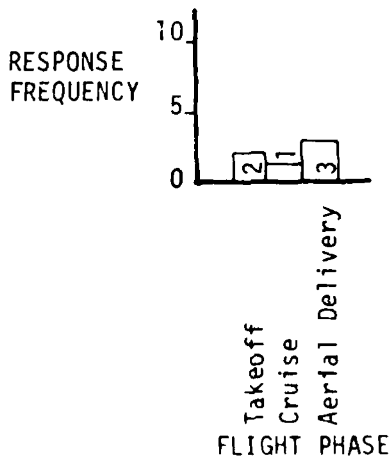

Figure 62. Phase of Flight During Which Workload Problems Occurred (n=6)

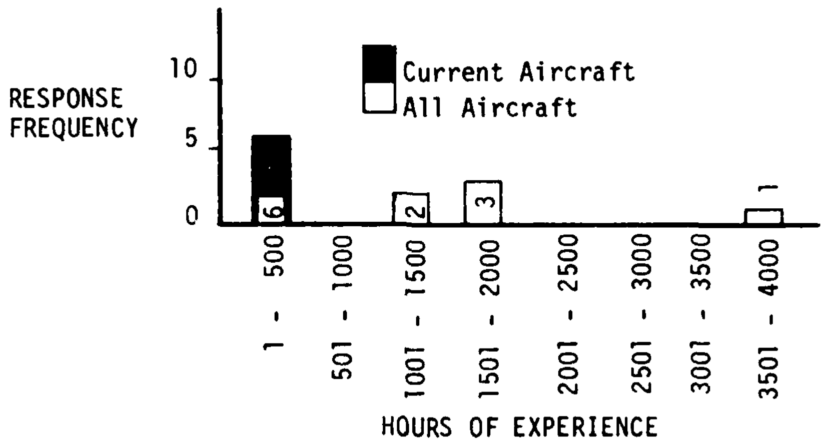

Figure 63. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=6)

1. F-105D, G Workload

The responding pilots indicated that operator errors which occurred during the weapon delivery phase precluded a high workload situation. Their responses indicate that these errors were associated with communication procedures or communication system malfunctions.

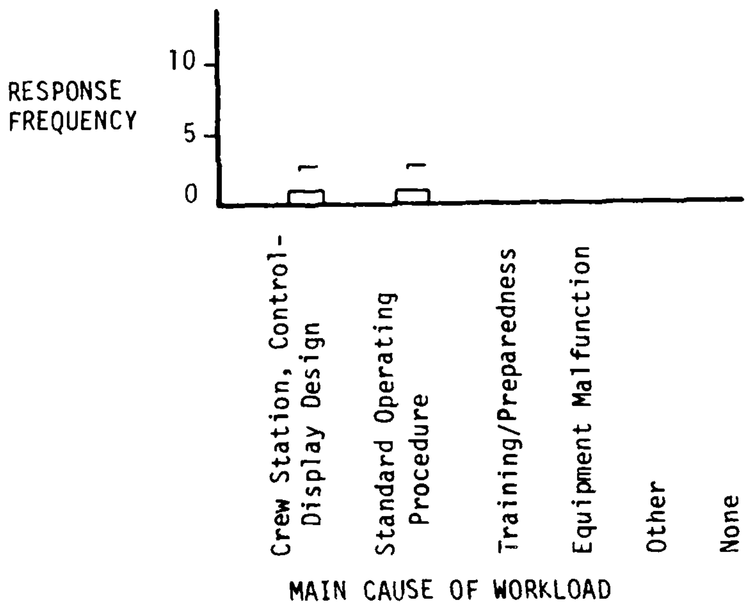

Figure 64. The Main Contributing Causes of Stated Workload Problems for all F-105D and F-105G Respondents (n=2)

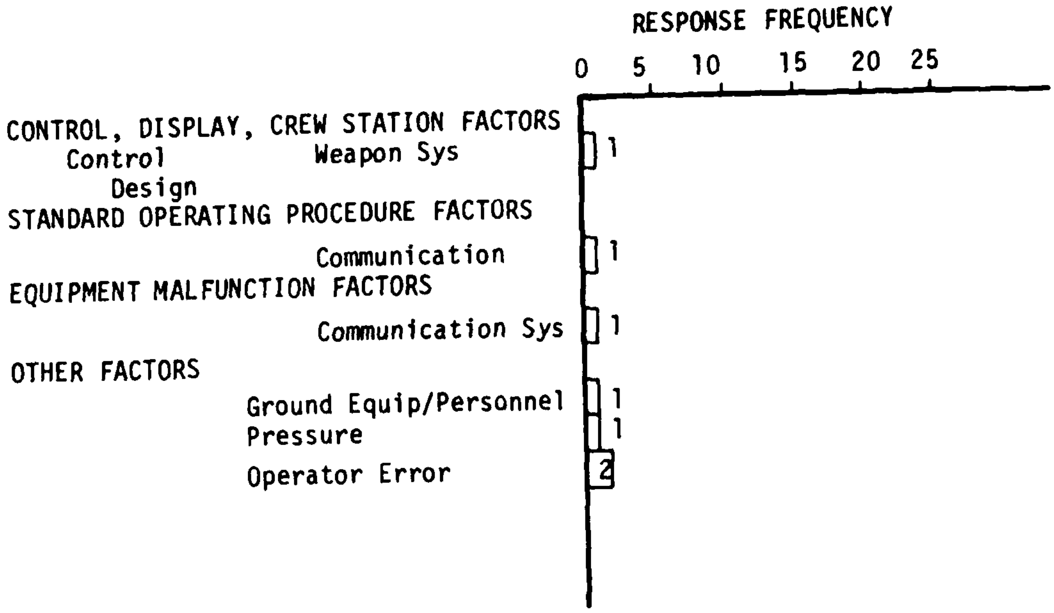

Figure 65. Contributing Factors of High Workload Reported for the F-105D, G

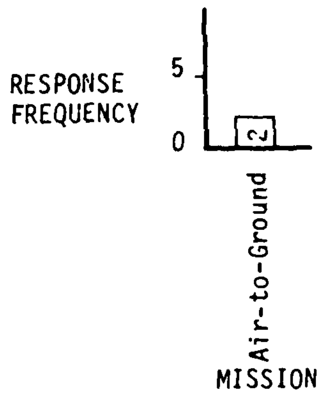

Figure 66. Mission Flown During Which Workload Problems Occurred (n=2)

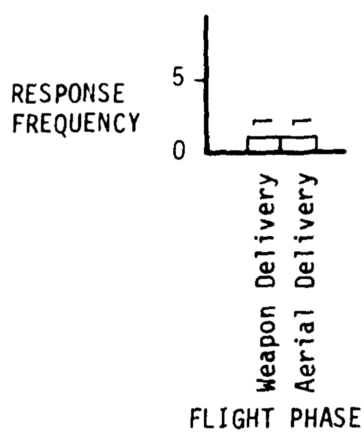

Figure 67. Phase of Flight During Which Worklcad Problems Occurred (n=2)

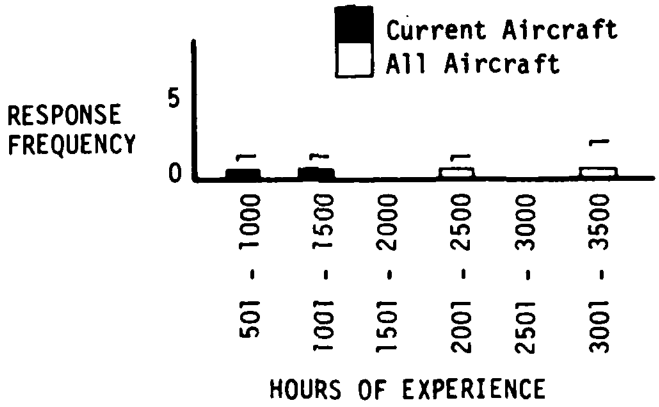

Figure 68. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=2)

m. F-111, A, D, E, F, Workload

Pilots reported that high workload situations were most prevalent during the low-level penetration portion of the air-to-ground mission. The high workloads were reported to occur as a result of subsystem failures (i.e., navigation system) and fatigue-induced operator errors. Pilots that reported fatigue as an associative cause indicated that flight scheduling (e.g., time of day of departure and flight length) was responsible for generating the fatigue.

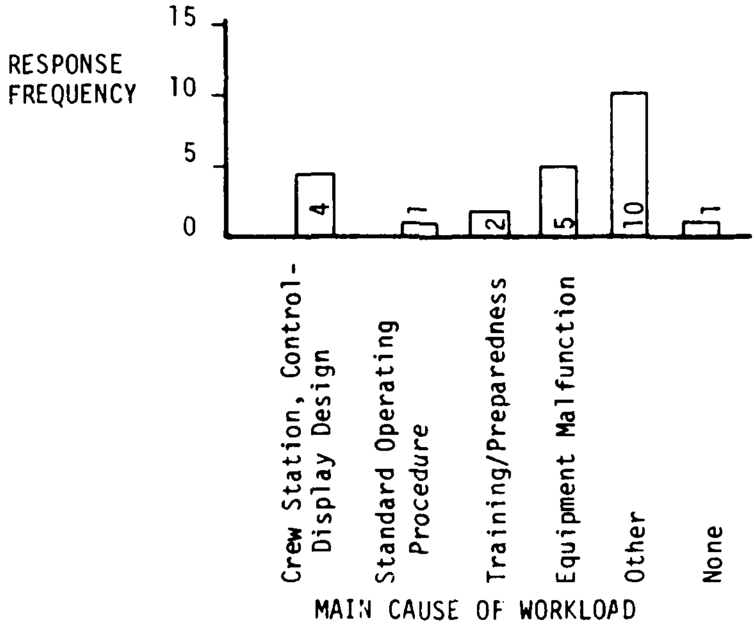

Figure 69. The Main Contributing Causes of Stated Workload Problems for all F-111, F-111A, F-111D, F-111E, F-111F Respondents (n=23)

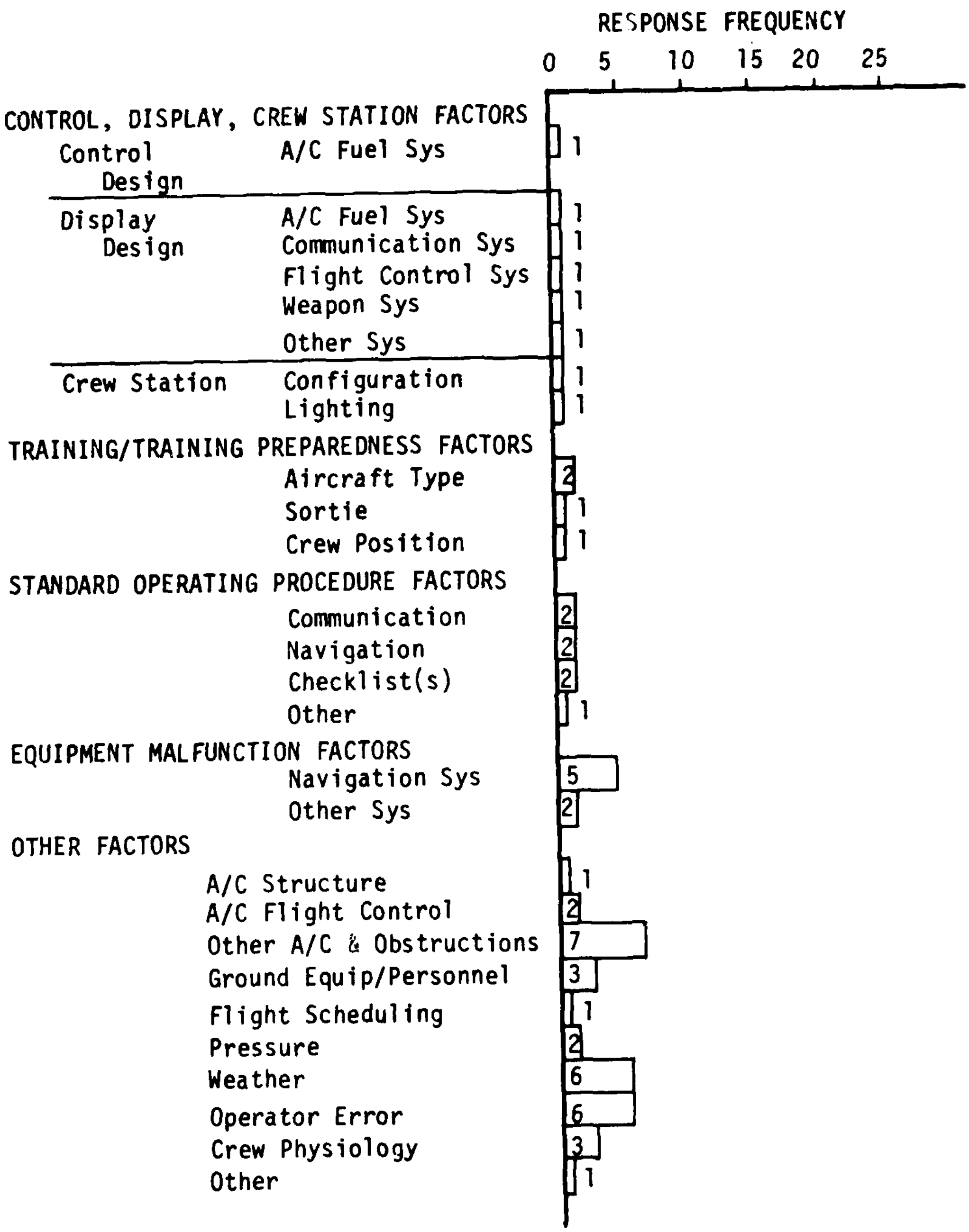

Figure 70. Contributing Factors of High Workload Reported for the F-111, A, D, E, F

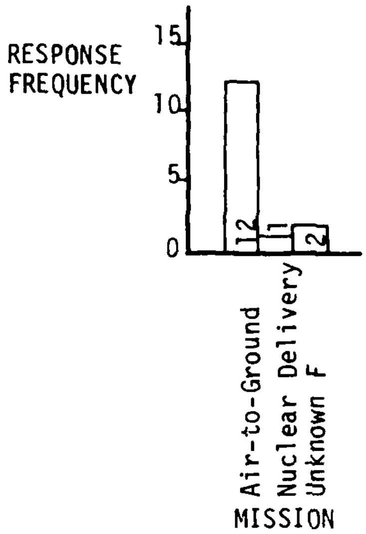

Figure 71. Mission Flown During Which Workload Problems Occurred (n=15)

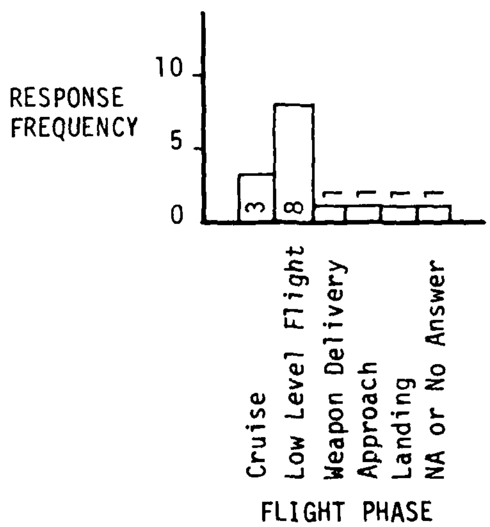

Figure 72. Phase of Flight During Which Workload Problems Occurred (n=15)

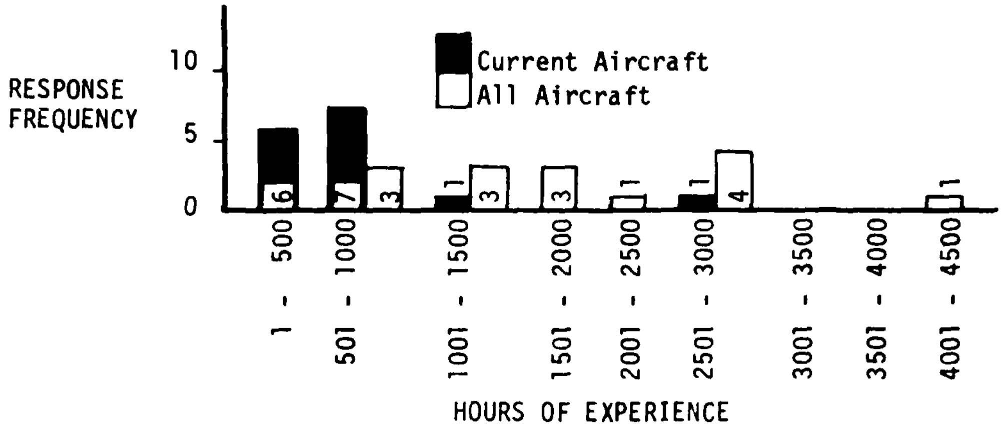

Figure 73. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=15)

n. FB-111A Workload

Surveyed pilots indicated that a high workload situation frequently occurs during the low-level penetration portion of their bombing mission. The pilots reported that frequently they assist the Weapon Systems Operator (WSO) (crewmember in the right seat) in the performance of his checklist tasks so that he can devote the necessary time for other mission essential tasks. This assistance by the pilot divides his attention to the point that the situation awareness suffers and the aircraft is allowed to descend closer to the ground than is intended. The pilots also indicate that higher workloads than desired resulted from the use of navigation information on displays that were, in their opinion, poorly located. Subsystem malfunctions (i.e., flight control, navigation, and environmental) were also reported to result in other high workload situations.

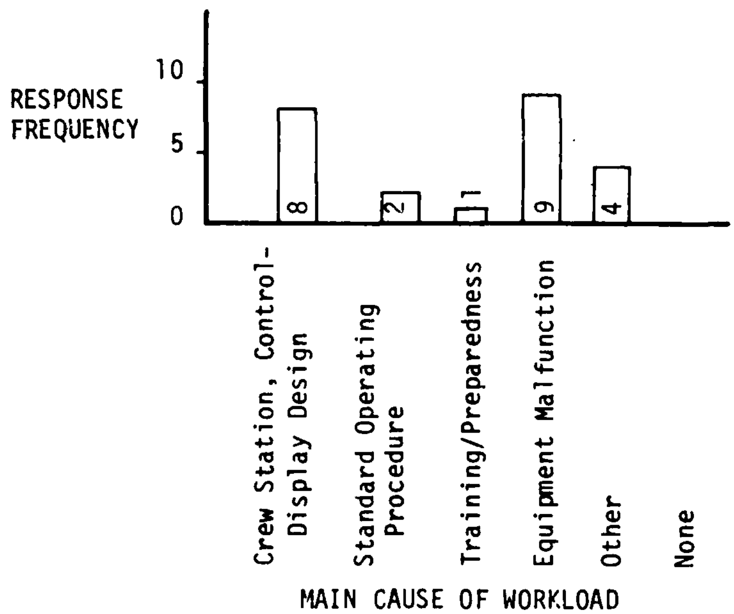

Figure 74. The Main Contributing Causes of Stated Workload Problems for all FB-111A Respondents (n=24)

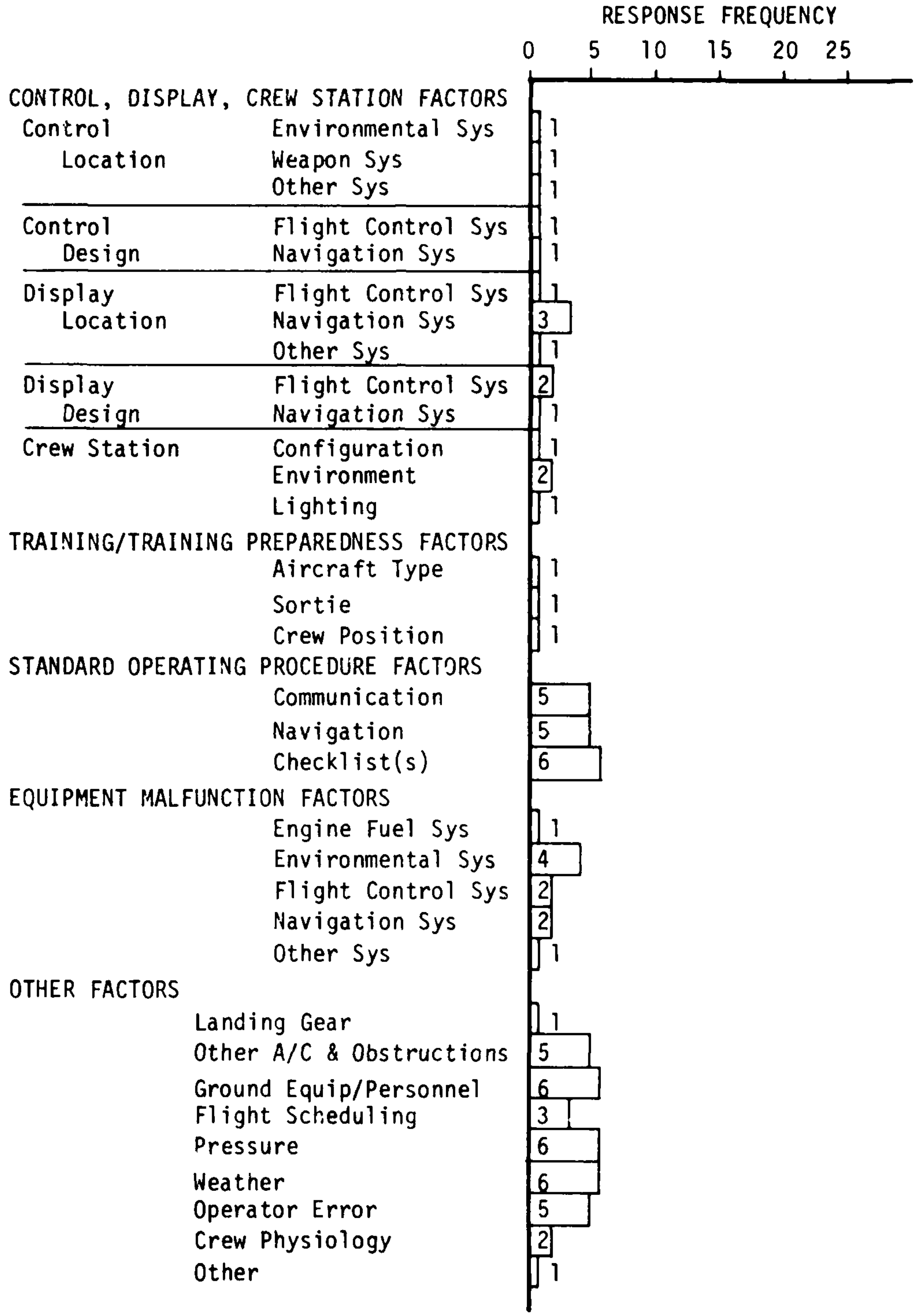

Figure 75. Contributing Factors of High Workload Reported for the FB-111A

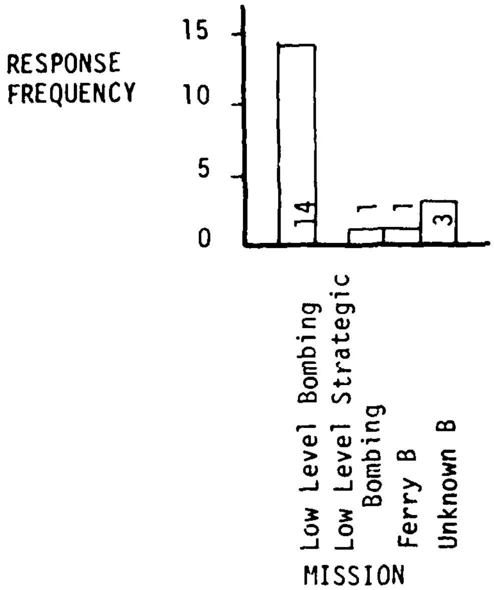

Figure 76. Mission Flown During Which Workload Problems Occurred (n=19)

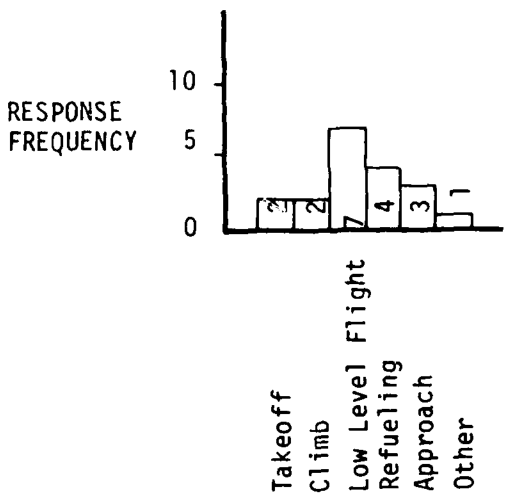

Figure 77. Phase of Flight During Which Workload Problems Occurred (n=19)

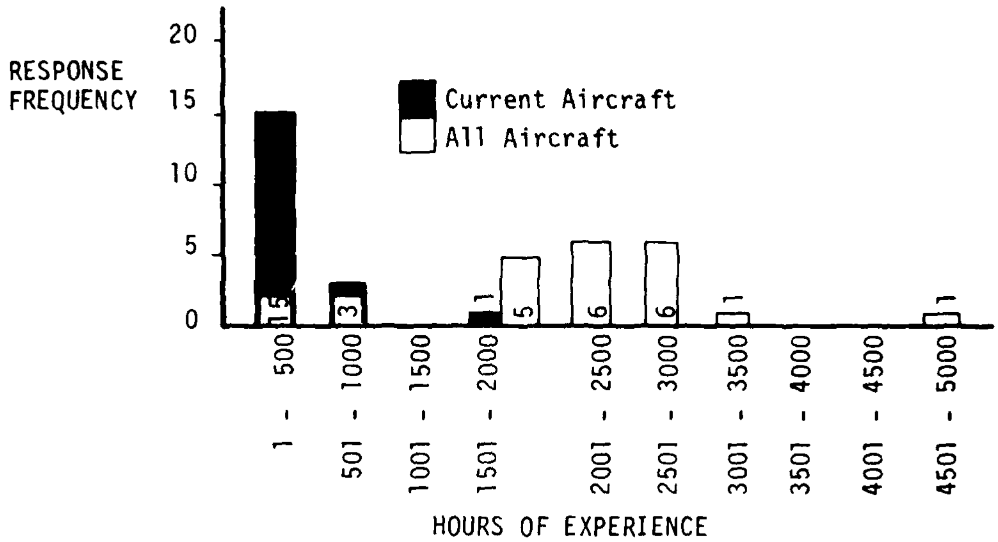

Figure 78. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=19)

AD-A107 758 BUNKER-RAMO CORP WESTLAKE VILLAGE CA ELECTRONIC SYST--ETC F/G 1/3
PILOT WORKLOAD: A SURVEY OF OPERATIONAL PROBLEMS.(U)
AUG 81 L BUTTERBAUGH, D WARNER, P LOVERING F33615-78-3614

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o. HC-130 Workload

The pilots who responded reported high workload situations associated with checklist accomplishment or subsystem malfunction while flying in the weather. The accomplishment of checklists while flying under IFR conditions reportedly resulted in missed items. Malfunction of the navigation system while flying in weather was also reported as an experienced high workload situation.

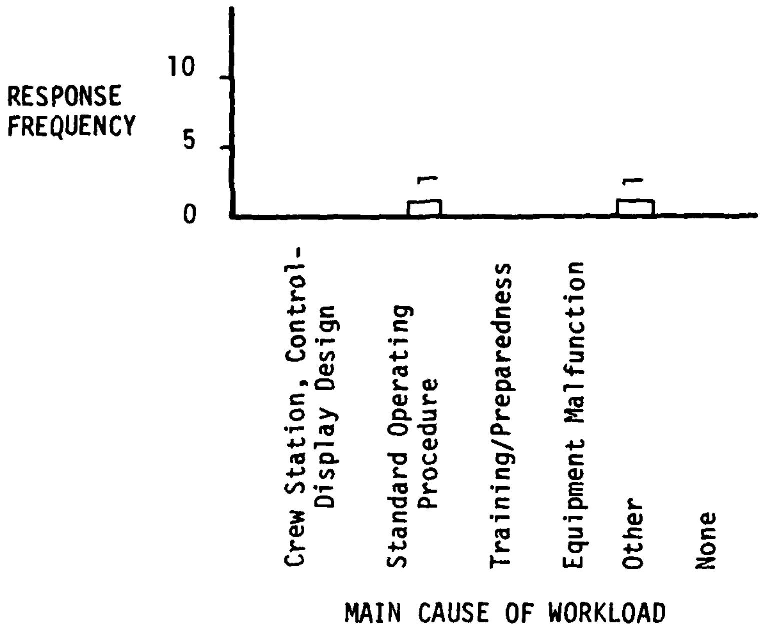

Figure 79. The Main Contributing Causes of Stated Workload Problems for all HC-130 Respondents (n=2)

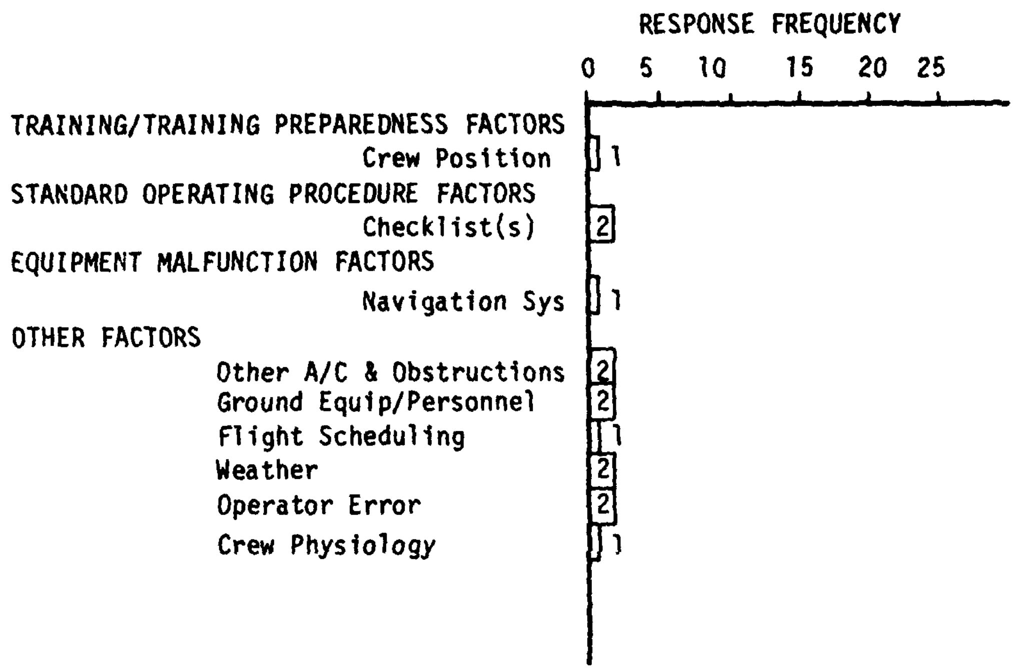

Figure 80. Contributing Factors of High Workload Reported for the HC-130

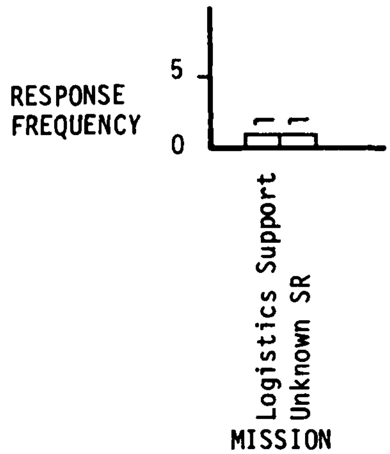

Figure 81. Mission Flown During Which Workload Problems Occurred (n=2)

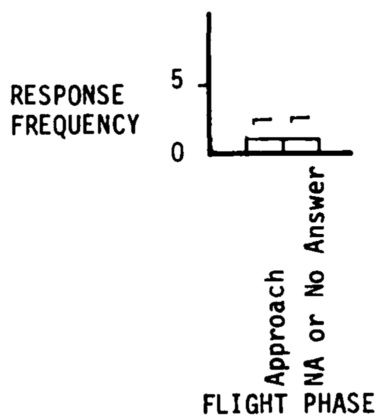

Figure 82. Phase of Flight During Which Workload Problems Occurred (n=2)

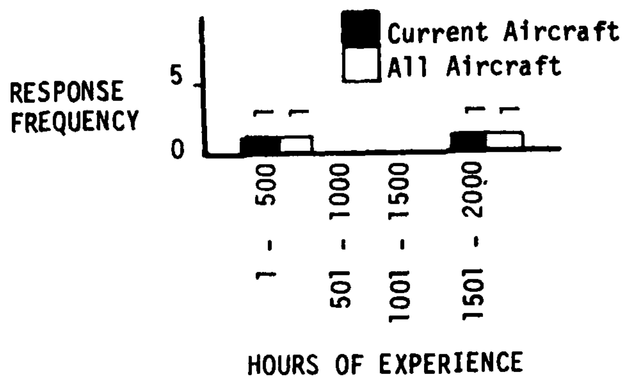

Figure 83. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=2)

p. HH-1 Workload

The responding pilot reported a situation where the airport control tower contributed to workload during an IFR approach to landing by questioning the pilot's request for an immediate IFR approach clearance, due to a "minimum fuel" condition. The pilot reported that this situation resulted in more communication traffic than was necessary and thus elevated his workload level during the approach.

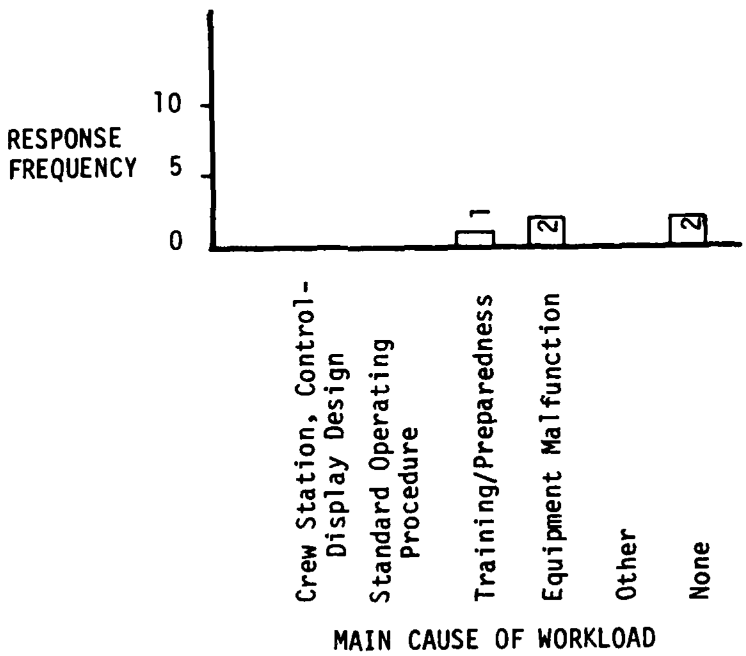

Figure 84. The Main Contributing Causes of Stated Workload Problems for all HH-1 Respondents (n=5)

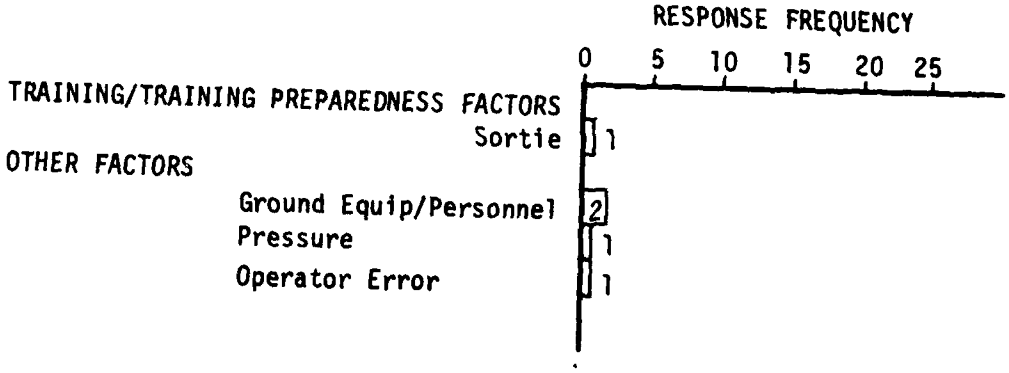

Figure 85. Contributing Factors of High Workload Reported for the HH-1

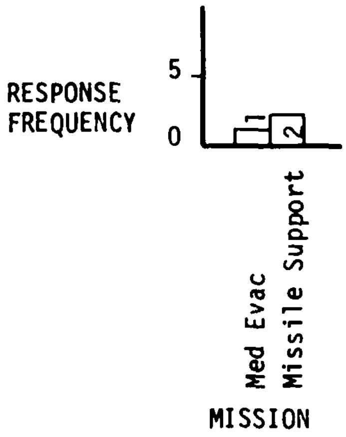

Figure 86. Mission Flown During Which Workload Problems Occurred (n=3)

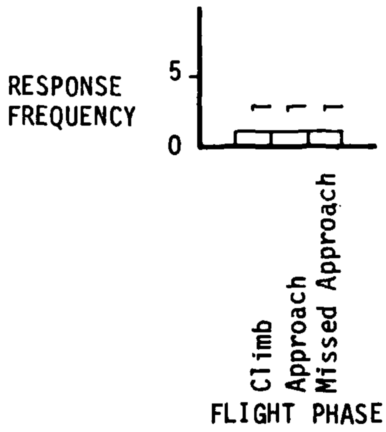

Figure 87. Phase of Flight During Which Workload Problems Occurred (n=3)

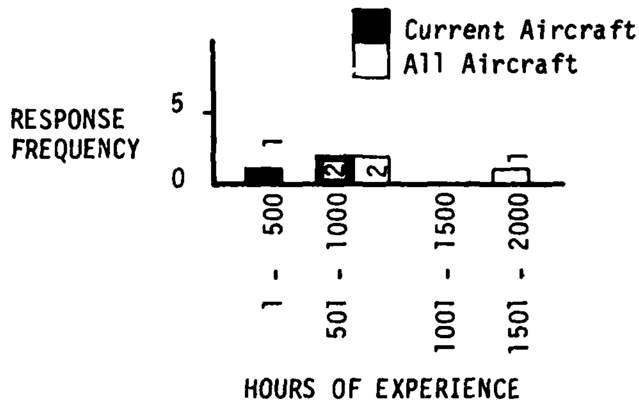

Figure 88. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=3)

q. HH-3E Workload

The responding pilot reported a high workload situation associated with an ineffective pitot-heating system. This situation occurred while flying under IFR conditions in mountainous terrain, and produced unreliable airspeed information. As a result, the pilot reportedly had to closely monitor his engine instruments, collective position (to maintain very slow rate of descent), and aircraft attitude to maintain adequate awareness of the aircraft's situation.

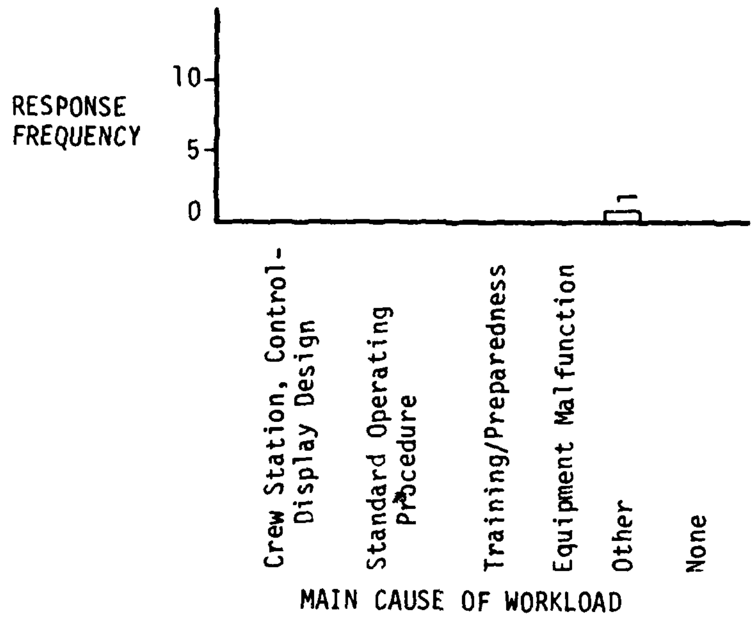

Figure 89. The Main Contributing Causes of Stated Workload Problems for all HH-3E Respondents (n=1)

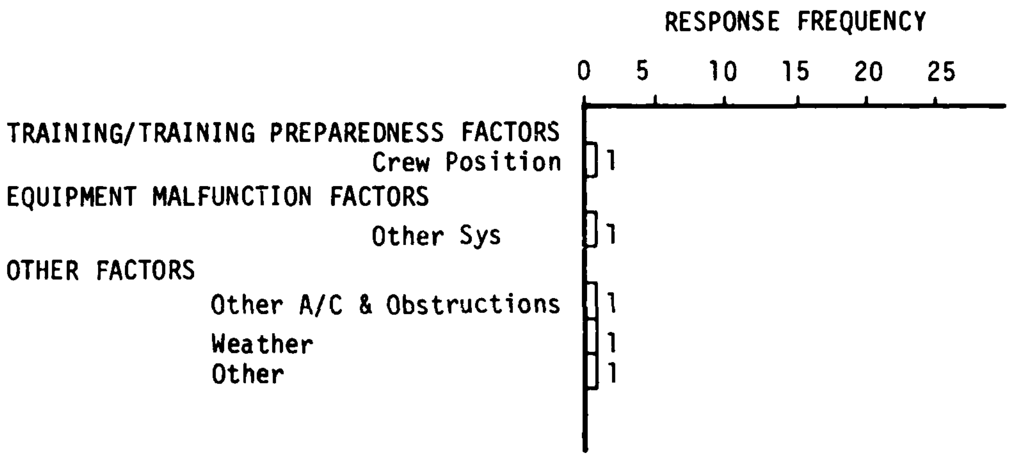

Figure 90. Contributing Factors of High Workload Reported for the HH-3E

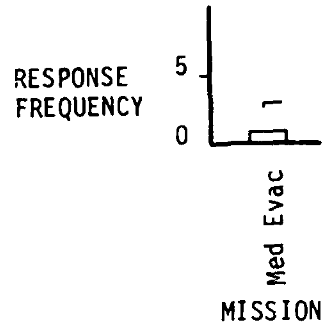

Figure 91. Mission Flown During Which Workload Problems Occurred (n=1)

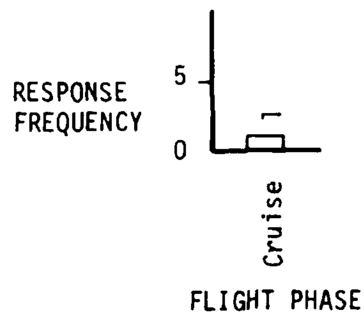

Figure 92. Phase of Flight During Which Workload Problems Occurred (n=1)

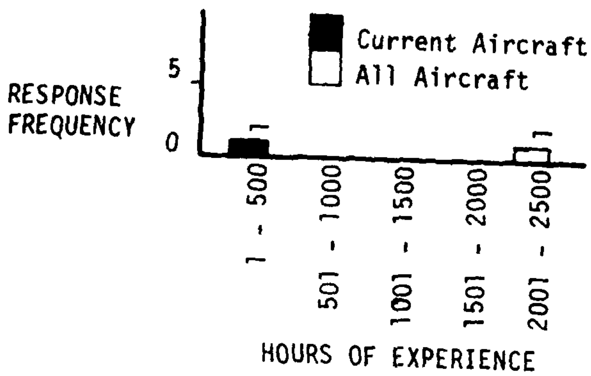

Figure 93. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=1)

r. HH-53B Workload

The pilot reported the occurrence of a high workload situation involving loss of power from both engines due to fuel siphoning while engaged in pickup of a downed pilot. The pilot indicated that it was the heads-up activity of the pickup which precluded his detection of a fuel problem until too late. The pilot further explained the high workload which naturally exists during a search and rescue involving a task force (i.e., heavy communication traffic with multiple agencies).

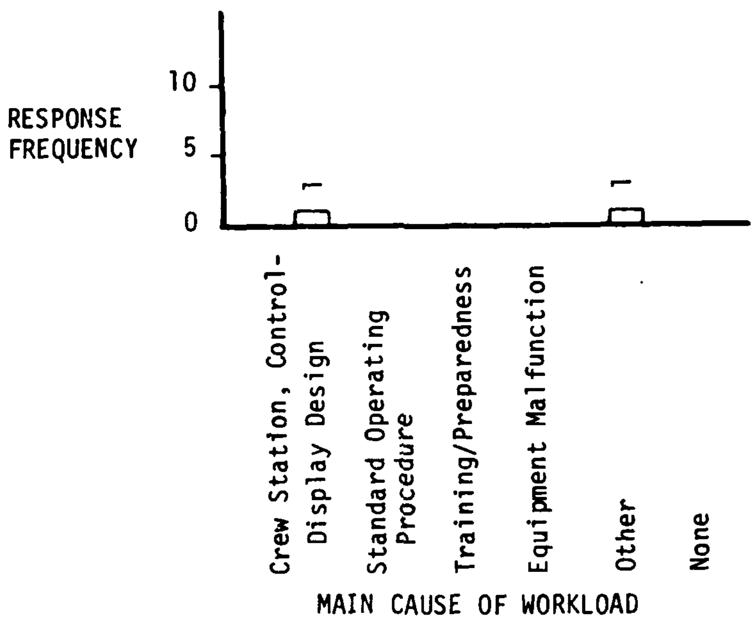

Figure 94. The Main Contributing Causes of Stated Workload Problems for all HH-53B Respondents (n=2)

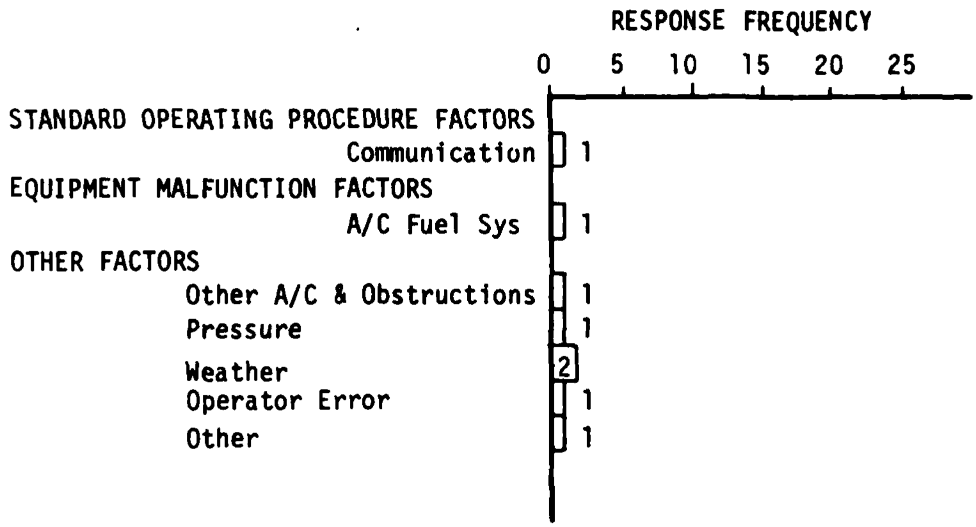

Figure 95. Contributing Factors of High Workload Reported for the HH-53B

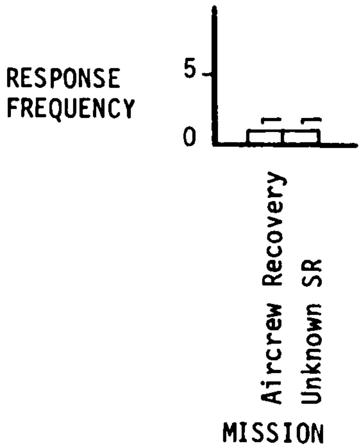

Figure 96. Mission Flown During Which Workload Problems Occurred (n=2)

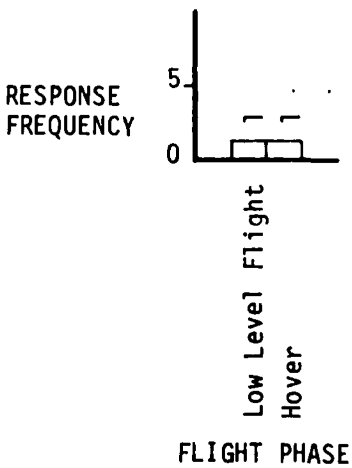

Figure 97. Phase of Flight During Which Workload Problems Occurred (n=2)

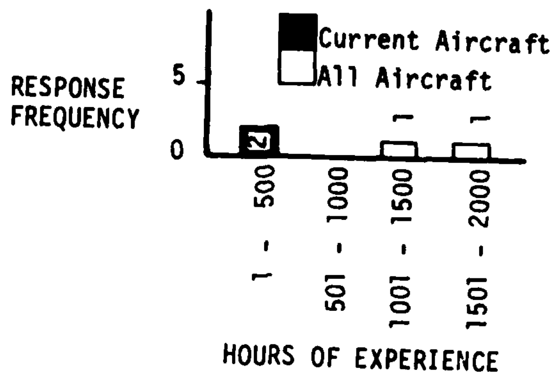

Figure 98. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=2)

s. KC-135A Workload

The pilots surveyed reported that a high workload situation occurs when takeoff data must be recomputed as a result of weather changes. The pilots indicated that these changes are usually required after taxiing to the runway which necessitates a hurried calculation to meet the scheduled departure time. They also reported that the recomputation is not as simple as it could be, requiring tables and graphs from the KC-135 Technical Order, and therefore incomplete or incorrect takeoff data often resulted. Pilots also reported high workload situations resulting from the communication equipment and the procedures associated with air-refueling and landing. Malfunctions of the propulsion, electrical, hydraulic, and environmental systems which led to high workloads, were also experienced.

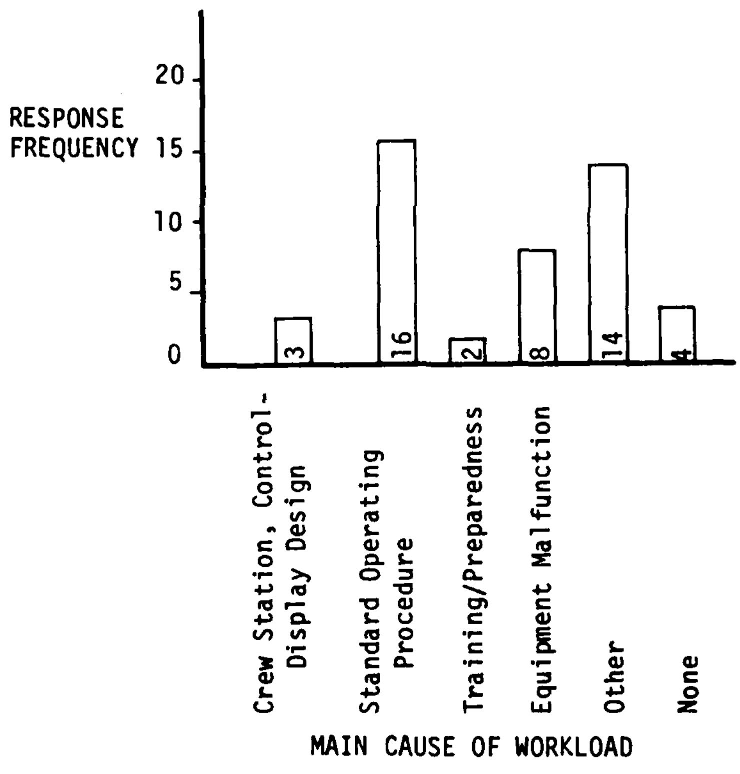

Figure 99. The Main Contributing Causes of Stated Workload Problems for all KC-135A Respondents (n=47)

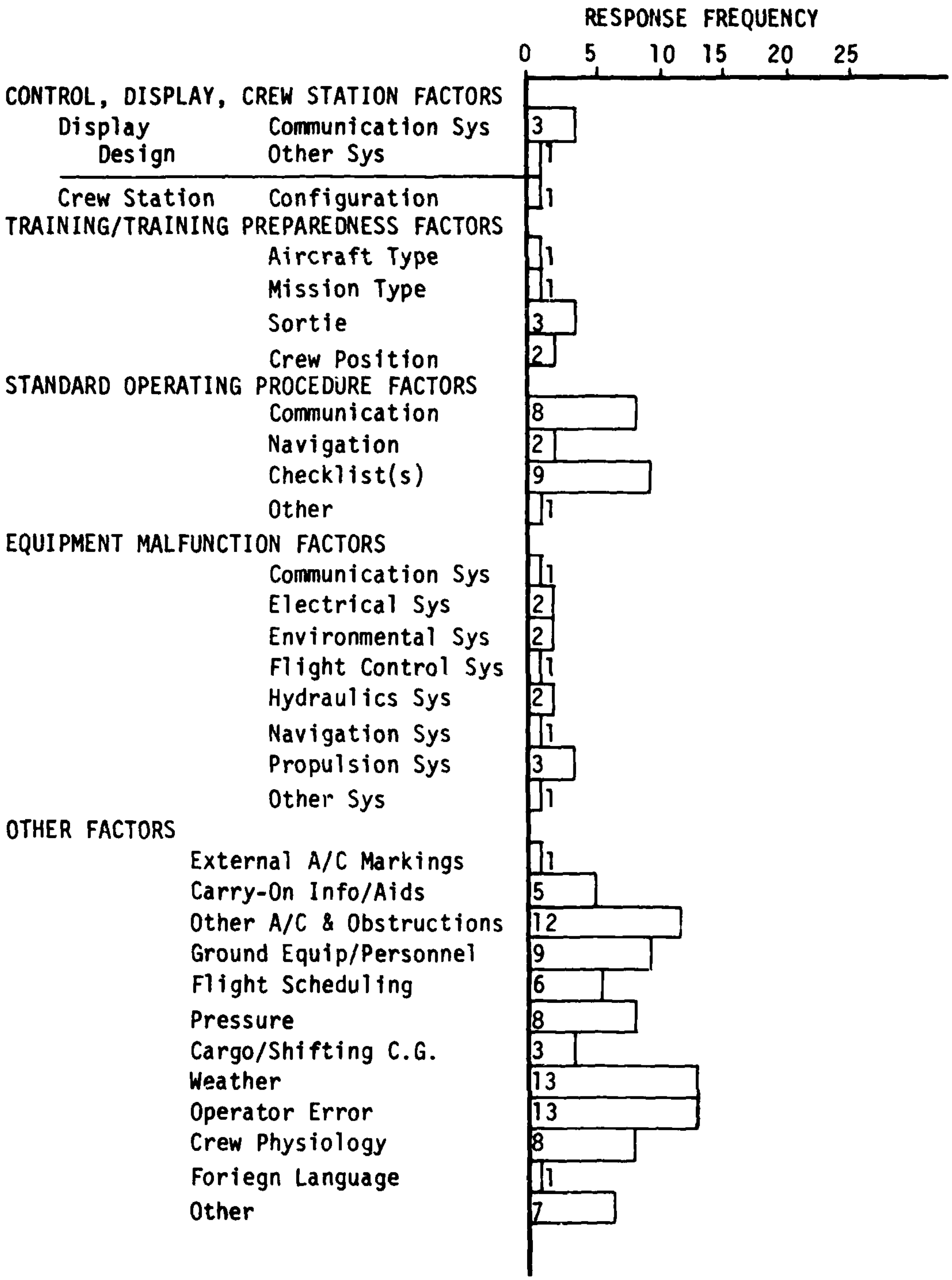

Figure 100. Contributing Factors of High Workload Reported for the KC-135A

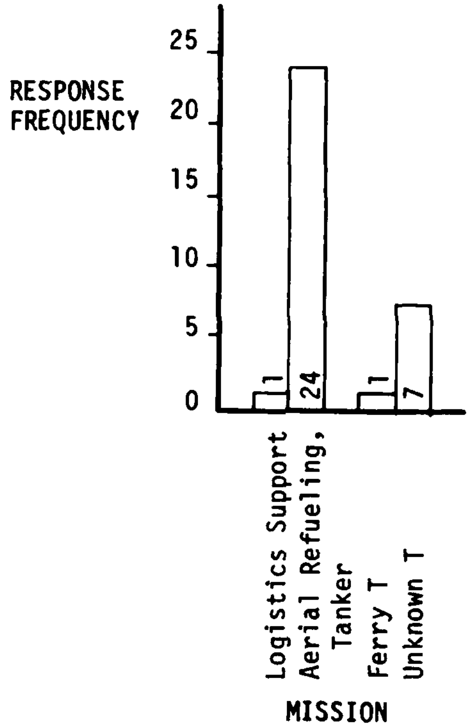

Figure 101. Mission Flown During Which Workload Problems Occurred (n=33)

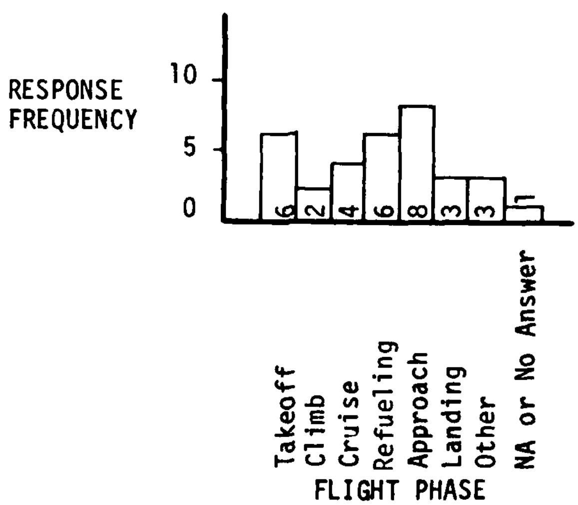

Figure 102. Phase of Flight During Which Workload Problems Occurred (n=33)

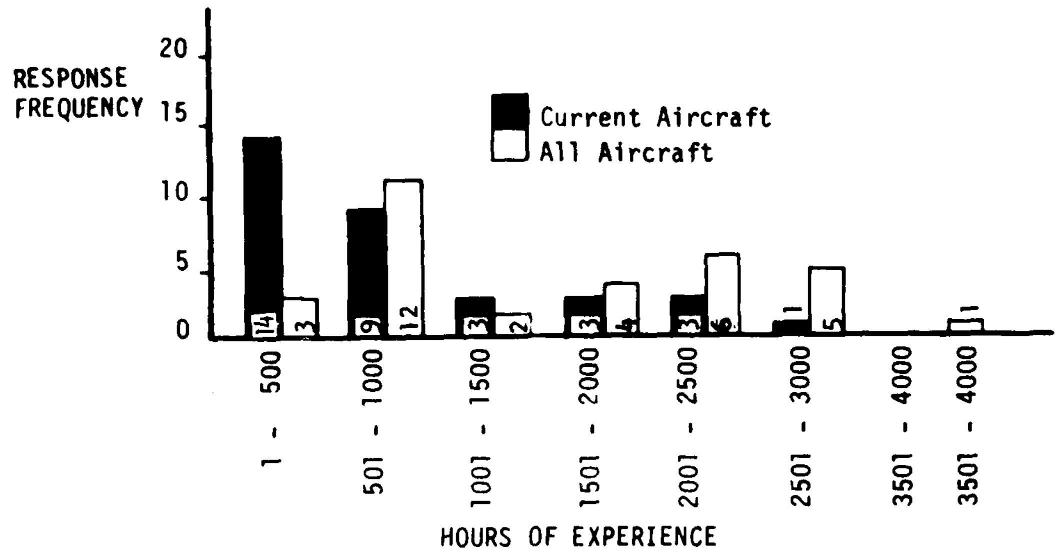

Figure 103. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=33)

t. O-2A Workload

The pilots reported high workloads associated with the communications necessary to direct incoming aircraft while flying in the forward air control (FAC) environment. They also indicated that the location of the radio control heads and the communication procedures required of the FAC mission often distracted them from maintaining the desired altitude. They also reported that they frequently have to correct attitude and altitude to maintain separation from the ground or other obstructions.

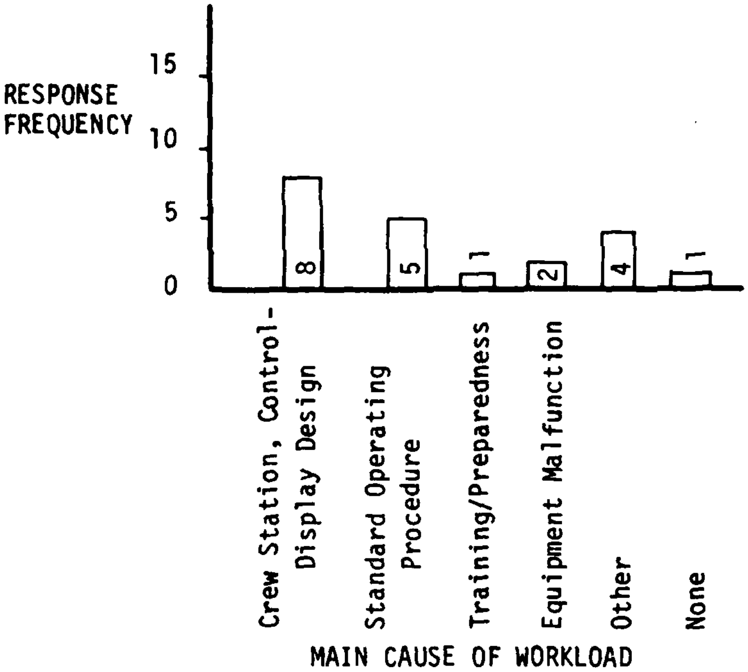

Figure 104. The Main Contributing Causes of Stated Workload Problems for all O-2A Respondents (n=21)

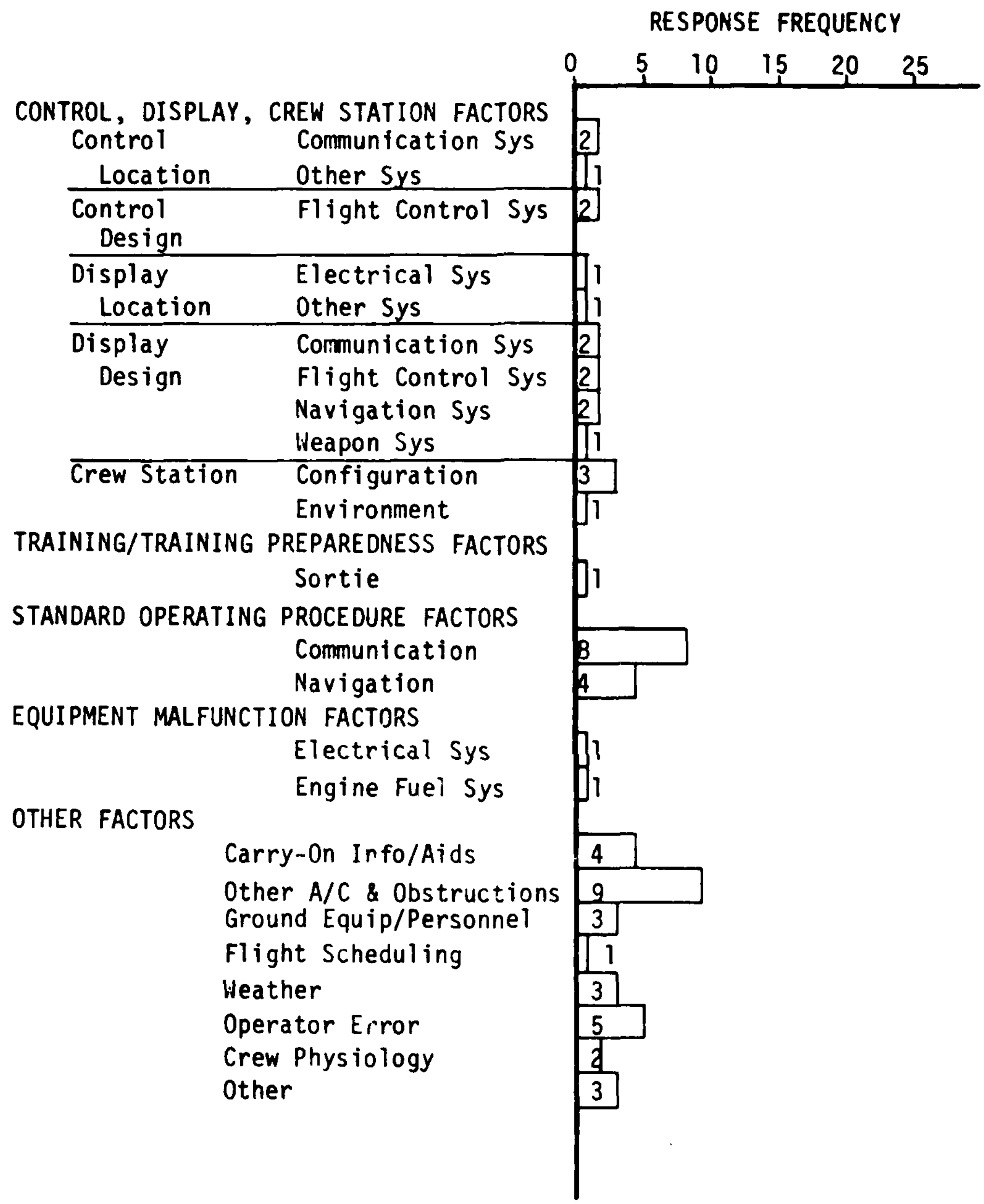

Figure 105. Contributing Factors of High Workload Reported for the O-2A

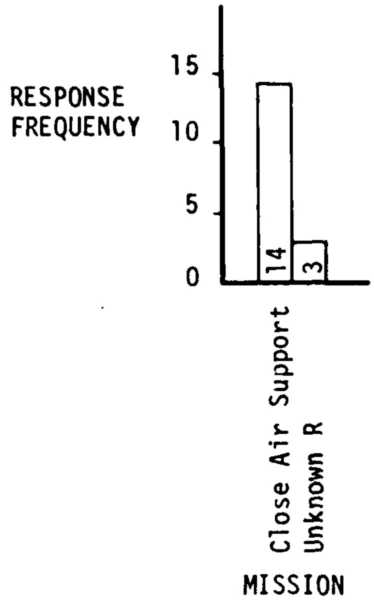

Figure 106. Mission Flown During Which Workload Problems Occurred (n=17)

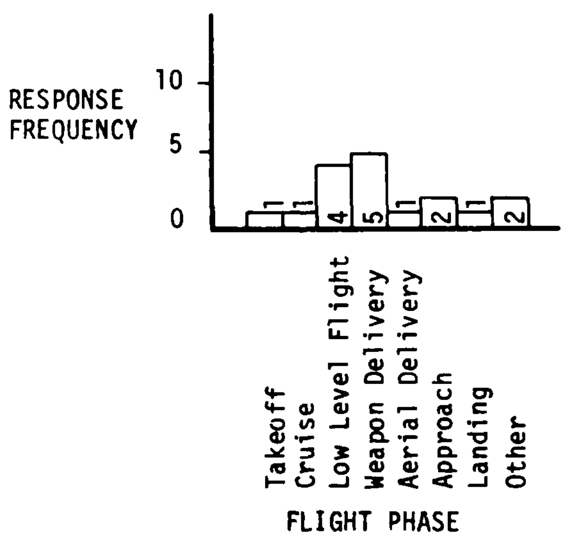

Figure 107. Phase of Flight During Which Workload Problems Occurred (n=17)

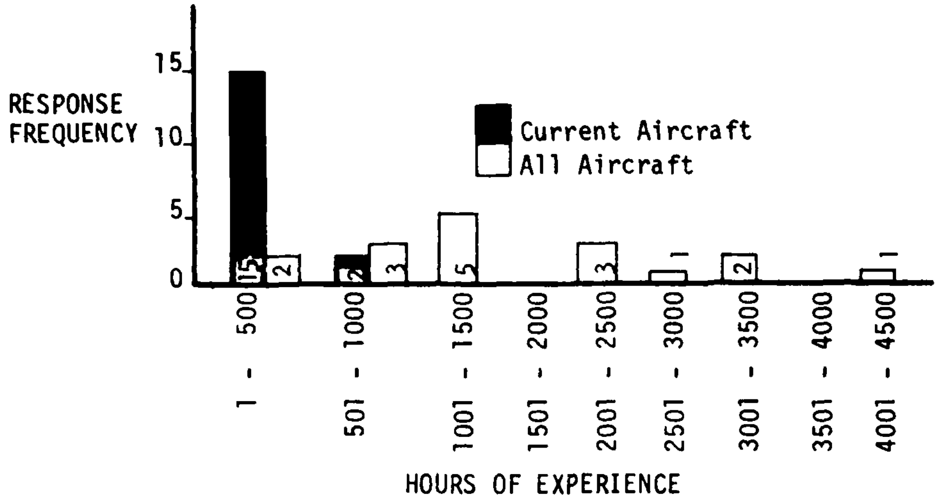

Figure 108. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=17)

u. OV-10A Workload

Surveyed pilots indicated that radio location and the heavy radio traffic required to direct numerous aircraft to the target area frequently caused operator errors. This type of situation is complicated, according to reported experiences, by the presence of unfolded maps on the pilot's lap needed to plot the data for directing the incoming aircraft.

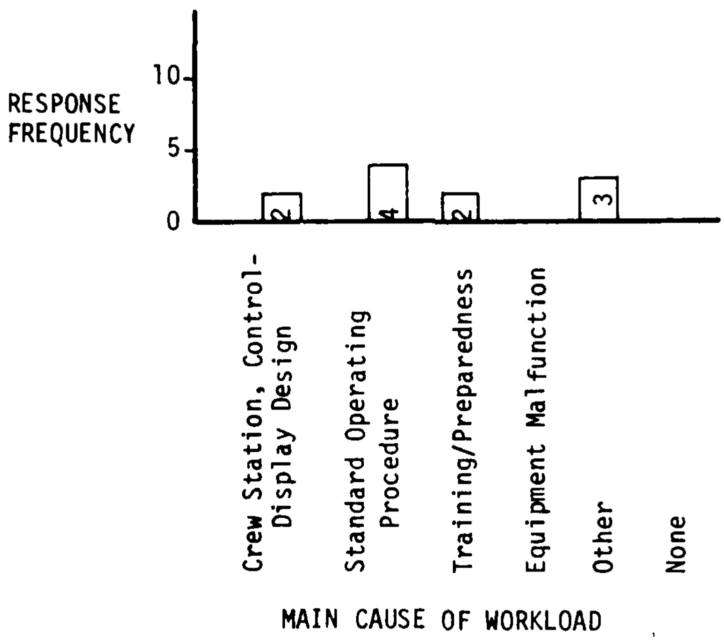

Figure 109. The Main Contributing Causes of Stated Workload Problems for all OV-10A Respondents (n=11)

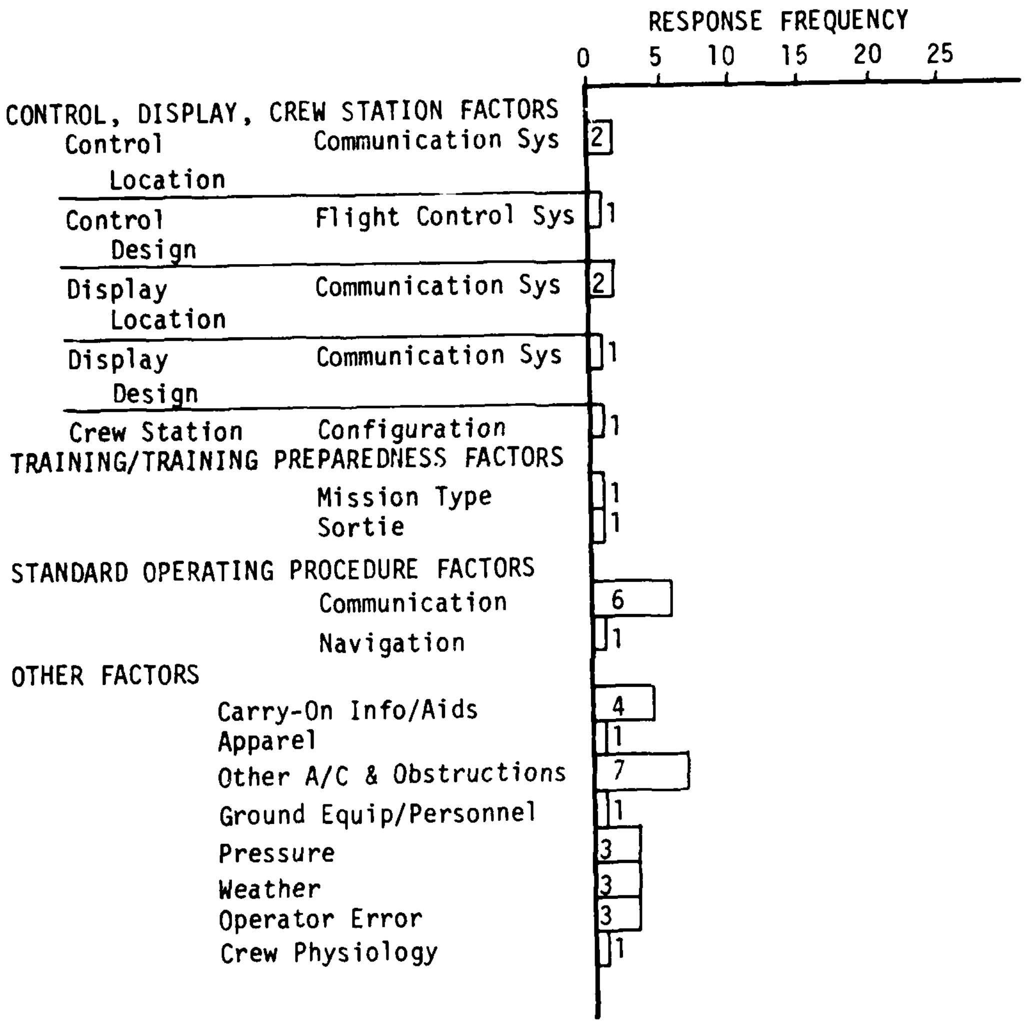

Figure 110. Contributing Factors of High Workload Reported for the OV-10A

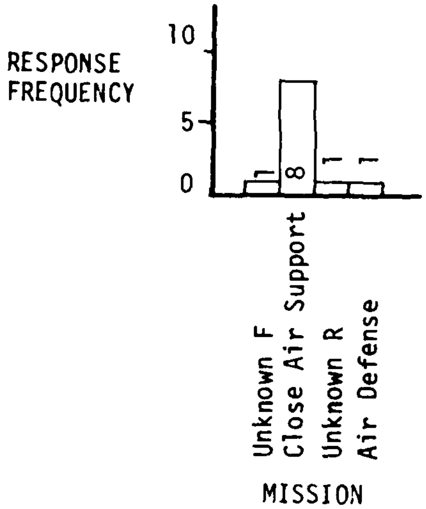

Figure 111. Mission Flown During Which Workload Problems Occurred (n=11)

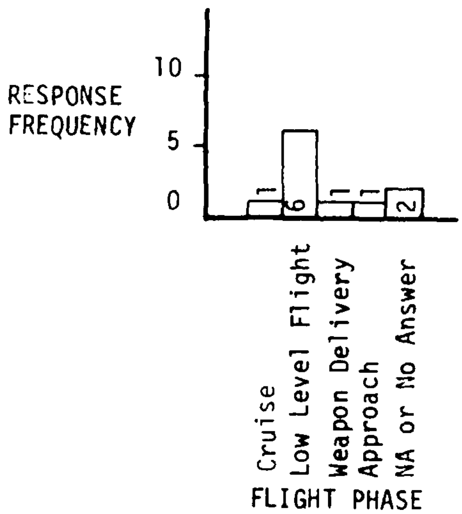

Figure 112. Phase of Flight During Which Workload Problems Occurred (n=11)

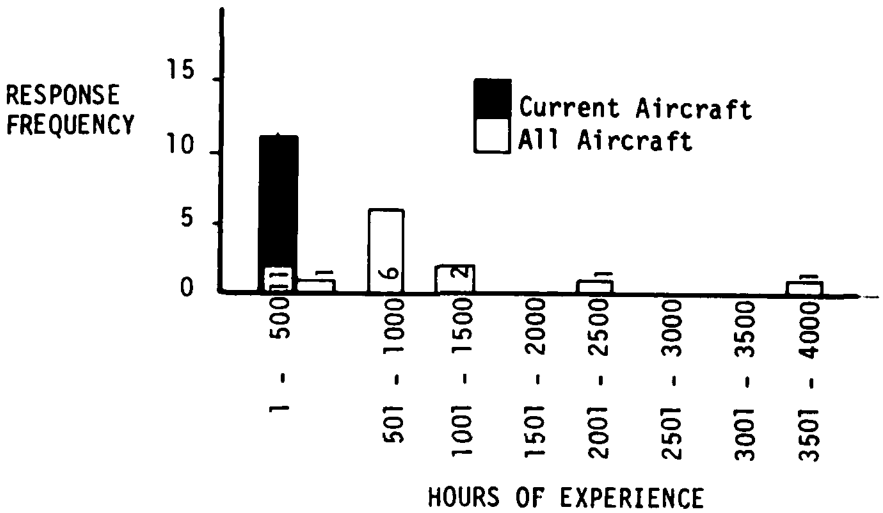

Figure 113. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=11)

v. RF-4C Workload

Pilots of the RF-4C reported high workload during the low-level portion of their reconnaissance mission. The surveyed pilots indicated that the design of the navigation system display and the navigation procedures used during this phase of the mission created high workload. Recounted high workload situations of the type described above were compounded by weather factors. The pilots reported that operator errors frequently accompanied the workload required to navigate, further adding to the overall workload level in such a situation.

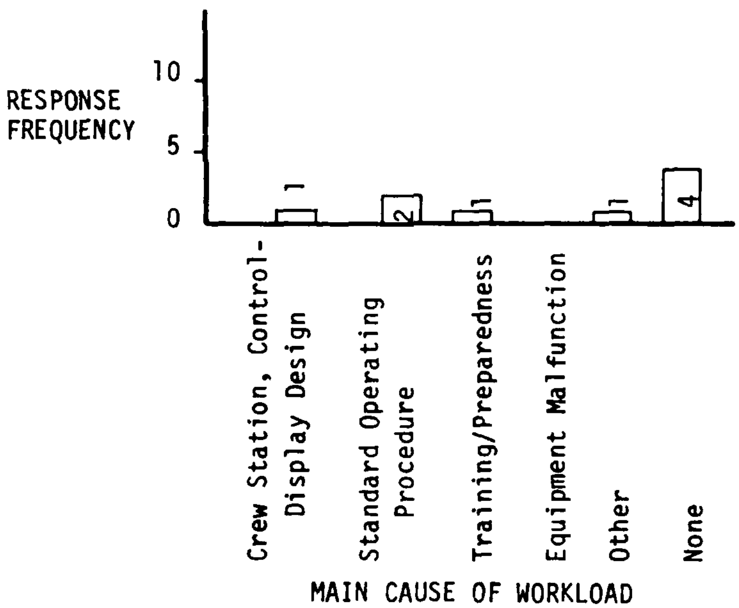

Figure 114. The Main Contributing Causes of Stated Workload Problems for all RF-4C Respondents (n=9)

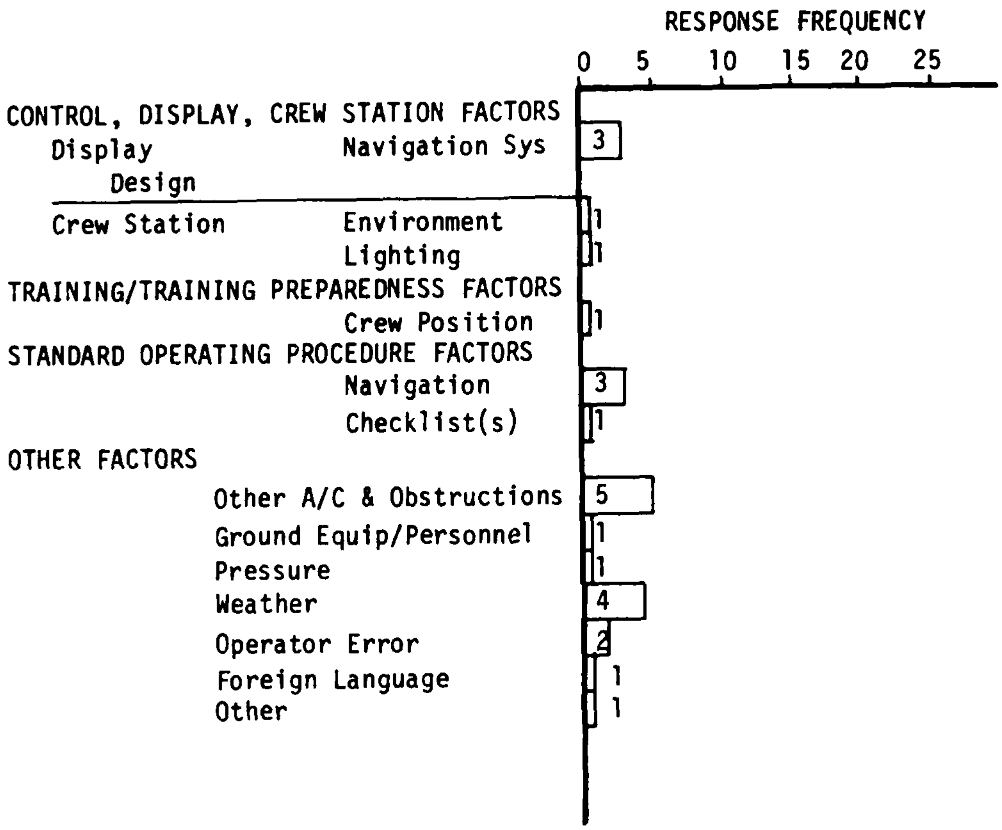

Figure 115. Contributing Factors of High Workload Reported for the RF-4C

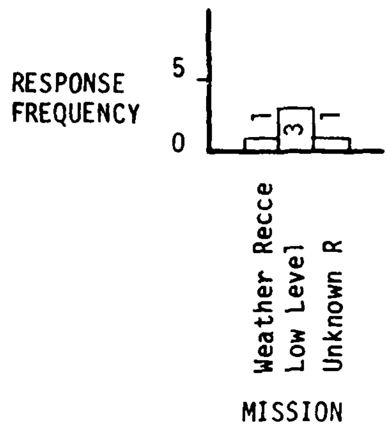

Figure 116. Mission Flown During Which Workload Problems Occurred (n=5)

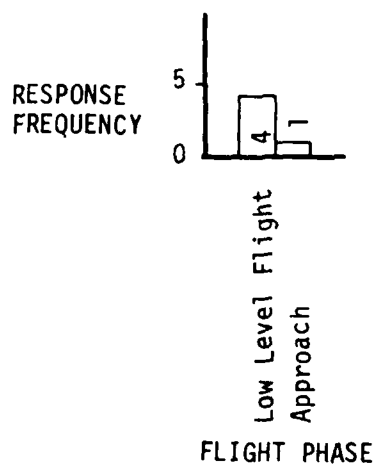

Figure 117. Phase of Flight During Which Workload Problems Occurred (n=5)

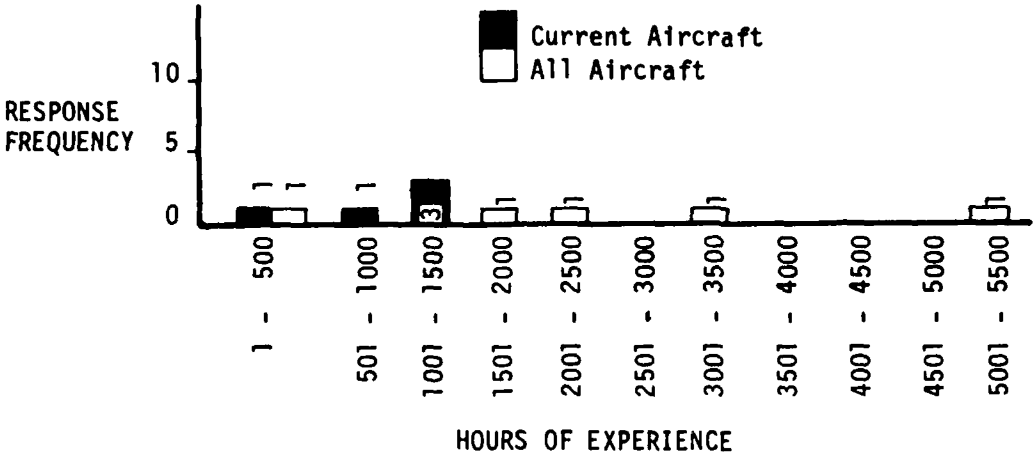

Figure 118. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) Aircraft (n=5)

w. SR-71 Workload

Pilots of the SR-71 did not respond with any specific high workload situations which they had experienced. However, they did indicate that reduced mobility of the arms as a result of the pressure suit made reaching difficult. They also indicated that circuit breakers (especially those on emergency checklists), and radio and navigation controls were too far aft to view while wearing a pressure suit. It was also reported that, because of the aircraft's performance capabilities and mission, there was more than the normal amount of information to monitor, which also contributed to a higher workload condition.

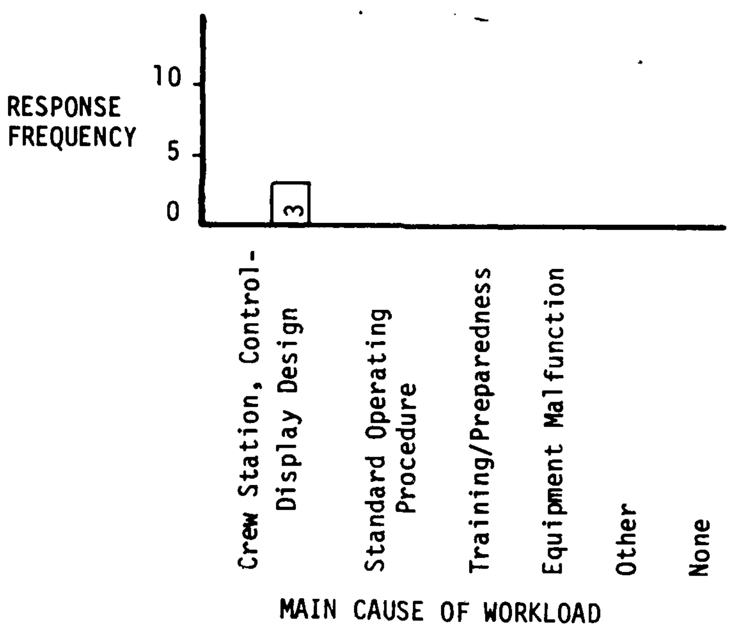

Figure 119. The Main Contributing Causes of Stated Workload Problems for all SR-71 Respondents (n=3)

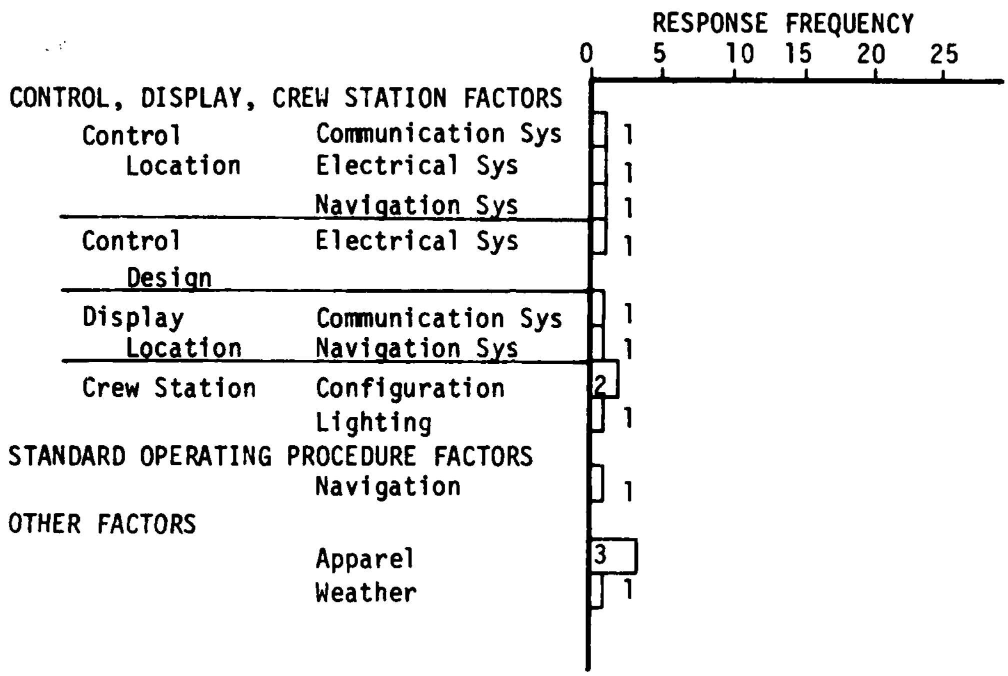

Figure 120. Contributing Factors of High Workload Reported by "General Gripes" for the SR-71

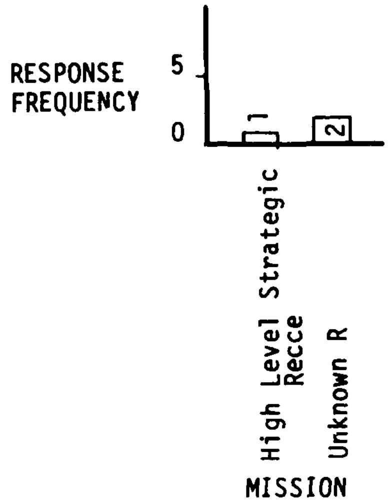

Figure 121. Mission Flown During Which Workload Problems Occurred for "General Gripe" Respondents (n=3)

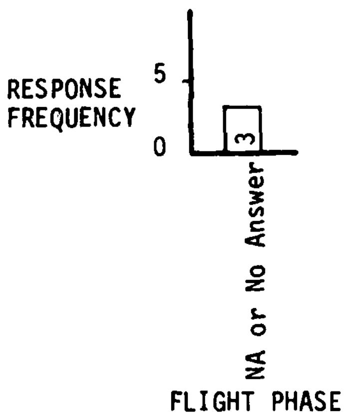

Figure 122. Phase of Flight During Which Workload Problems Occurred for "General Gripe" Respondents (n=3)

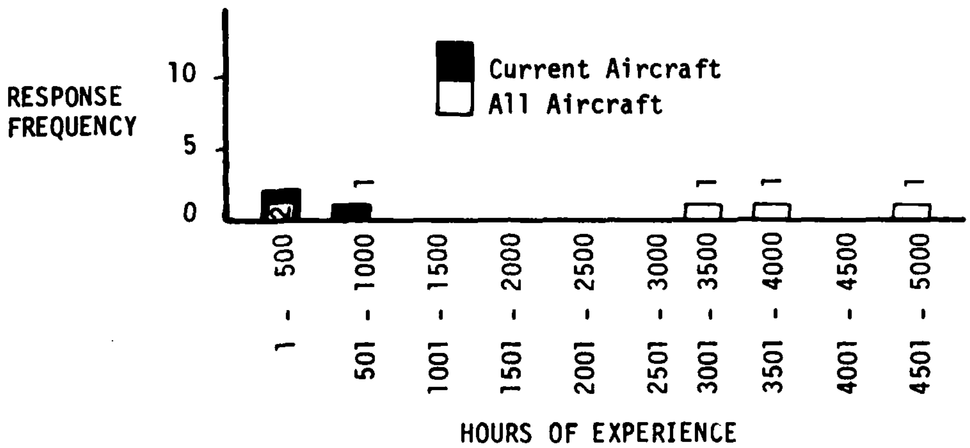

Figure 123. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft Reported by "General Gripe" Respondents (n=3)

x. UH-1, F, H, P, Workload

Surveyed pilots reported that the nonstandard schedule associated with flying special airlift missions (e.g., VIP transportation) can and does, at times, require flying without regard to crew duty day or crew rest. Pilots also reported that the pressure that is sensed with regard to meeting a scheduled pickup and/or delivery can create errors, which elevates the workload. Pilots flying the UH-1 on search and rescue missions reported that weather had a significant impact on the workload normally associated with these missions.

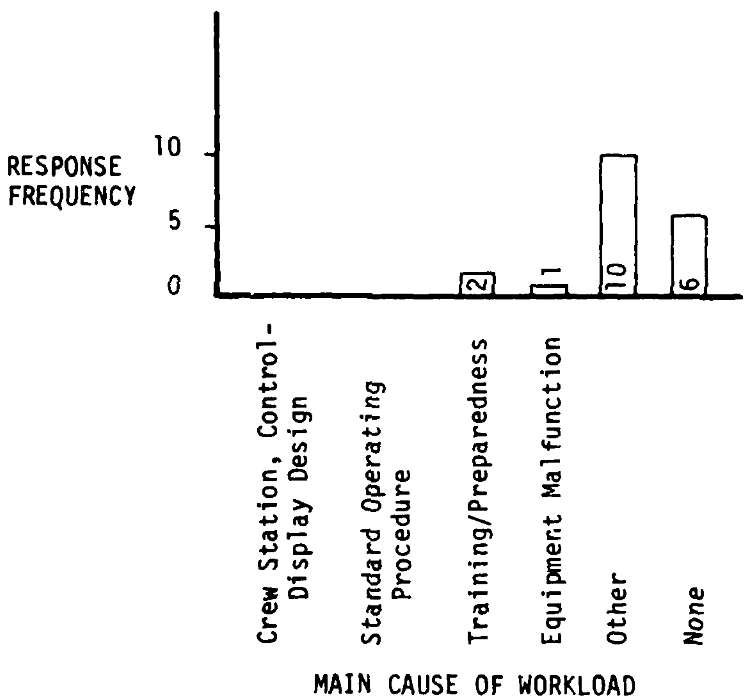

Figure 124. The Main Contributing Cause of Stated Workload Problems for all UH-1, UH-1F, UH-1N, and UH-1P Respondents (n=19)

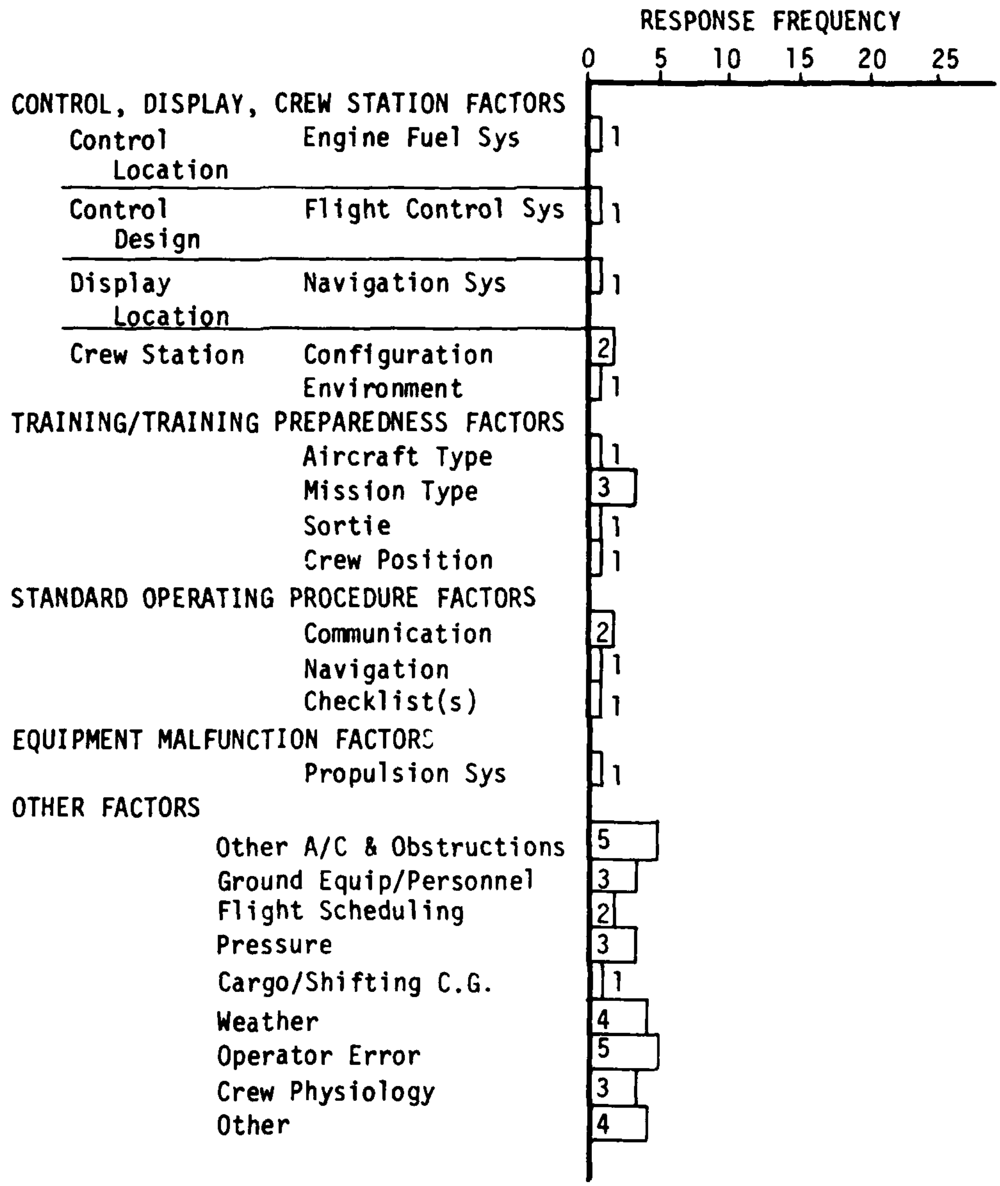

Figure 125. Contributing Factors of High Workload Reported for the UH-1, F, N, P

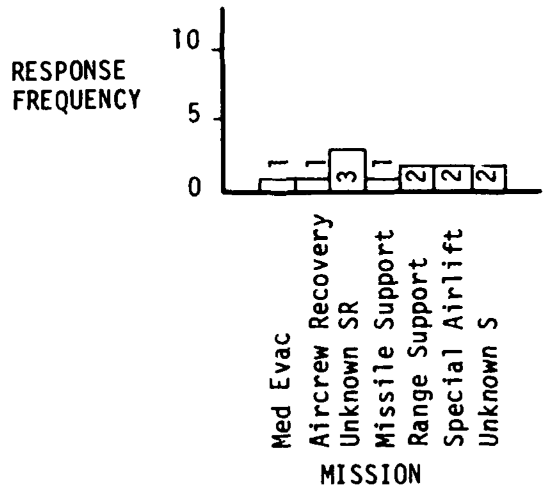

Figure 126. Mission Flown During Which Workload Problems Occurred (n=12)

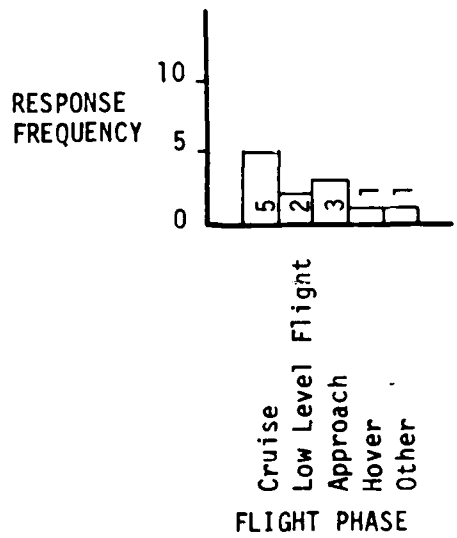

Figure 127. Phase of Flight During Which Workload Problems Occurred (n-12)

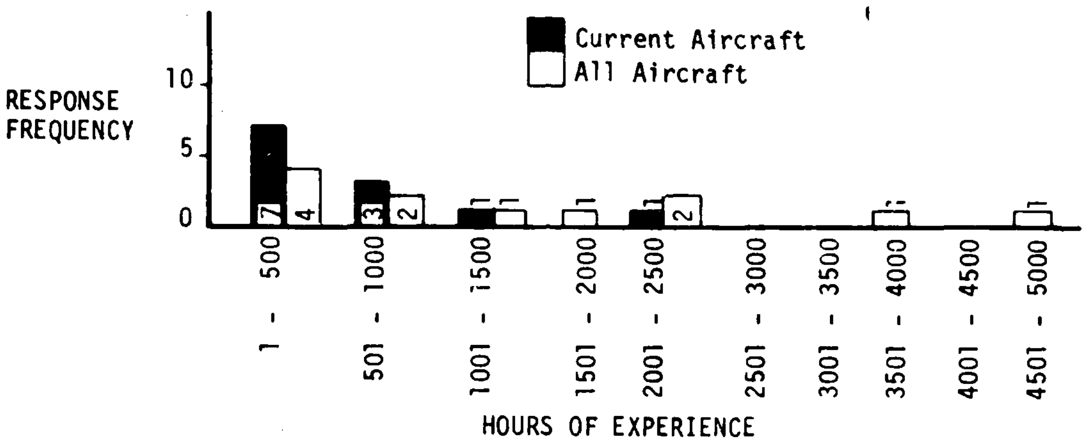

Figure 128. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=12)

y. U-2R Workload

The pilots surveyed reported general problems of the crew station which made the flying and accomplishment of the reconnaissance mission more difficult. The pilots reported that the communication and navigation control heads were located in a position such that their visibility and operability were very difficult. They also reported that the IFF controls were difficult to access and operate with the pressure suit and gloves.

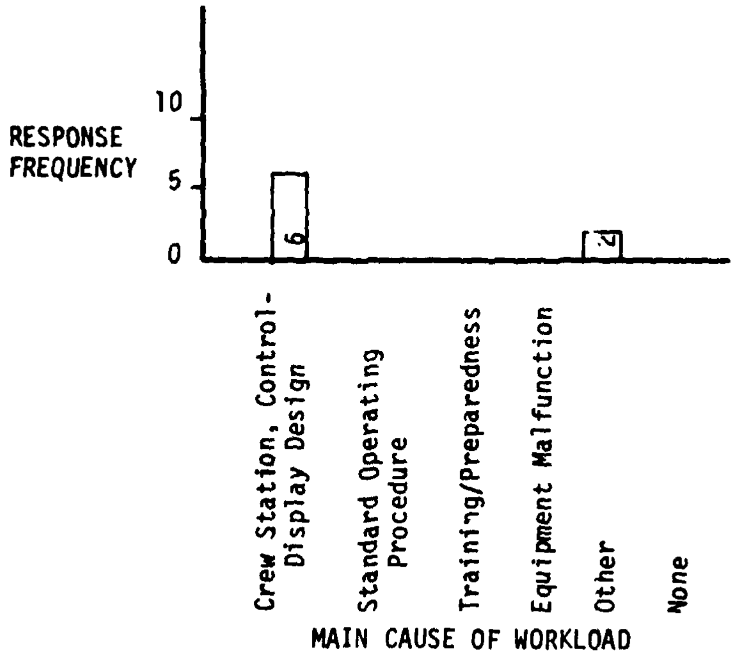

Figure 129. The Main Contributing Causes of Stated Workload Problems for all U-2R Respondents (n=8)

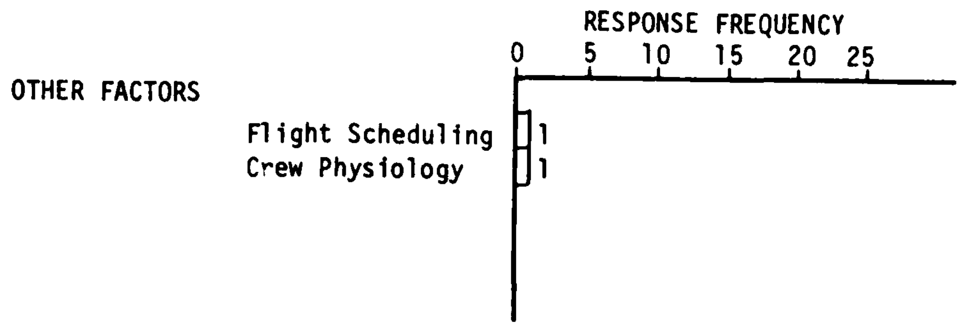

Figure 130. Contributing Factors of High Workload Reported for the U-2R

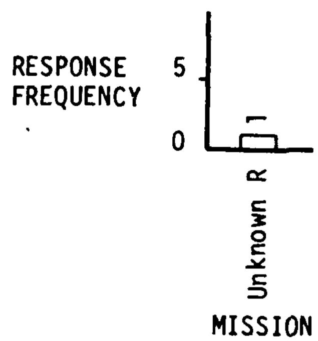

Figure 131. Mission Flown During Which Workload Problems Occurred (n=1)

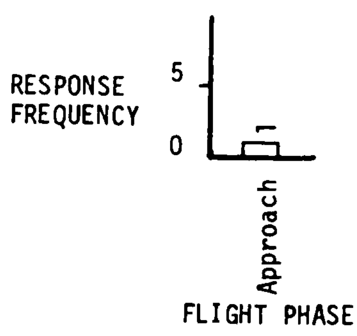

Figure 132. Phase of Flight During Which Workload Problems Occurred (n=1)

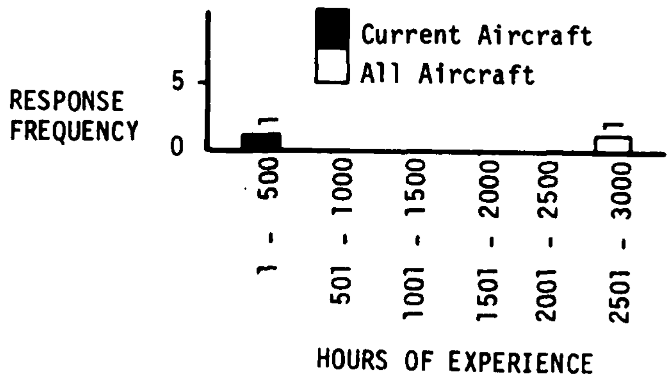

Figure 133. Number of Hours of Prior Flying Experience in (a) Current Aircraft Type and (b) all Aircraft (n=1)

SECTION IV

CONCLUSIONS AND RECOMMENDATIONS

The data from this survey indicate that high workload results from a variety of cockpit-related causes. Furthermore, the data show multiple contributing causes in virtually all of the recounted situations. The situations represented in Section III are experienced repeatedly, some more frequently than others. But data provided by the pilots, upon which the histograms are based (Section III), also indicate the existence of a variety of "one-of-a-kind" situations.

1. CONCLUSIONS

As the data show, high workloads are the result of crew station designs, in-flight procedures, training/preparedness equipment malfunctions, and other causes associated with the man-machine interface and the mission.

The crew station design is reportedly a contributing factor in a variety of ways, depending on the aircraft. For instance, the location of the adjustment controls for the C-141A radar display, the U-2R lighting, the lack of wanted altitude and navigation systems in the A-10A, and the dispersion of the station-keeping equipment in the C-130, are all reported as contributing factors in recounted high workload situations.

The in-flight procedures associated with checklists, communication, and navigation were likewise reported as contributors to a high workload situation, varying with each aircraft. For example, the heavy communication traffic and navigation tasks associated with target locating as a part of the FAC mission of the O-2A and OV-10A, the numerous and closely-spaced pre-drop checklists in the C-130, and the checklists performed during low-level portions of the FB-111 mission, are reported activities that have contributed to high workloads.

Training and preparedness with regard to the aircraft, the mission or a special sortie also were reported to influence workload levels. And, as were the previous causes, these too were reportedly aircraft specific. The F-16 pilots, for instance, reported that portions of high workload situations were the direct result of their incomplete familiarity with the aircraft. Unfamiliarity with regard to a certain geographical area (i.e., the European Theatre) and the accompanying Air Traffic Controller language differences, as reported by C-141A and C-5A pilots, are another example.

Equipment malfunctions associated with specific aircraft were causes of many high workloads. For instance, the F-4 pilots recounted high workload situations involving communication systems, environmental systems, flight control systems, and navigation systems failures. The B-52 pilots reported communication system, electrical system, navigation system, oil system, propulsion system, and environmental system failures as contributing to various high workload situations.

Other causes of high workloads reportedly existed throughout the USAF flying Commands. Weather factors resulting in IFR flight and other obstructions (i.e., the ground and other aircraft) most frequently contributed to high workloads. Regardless of whether the ground or other aircraft was a part of the mission or not (e.g., low-level flight vs. a mountain or formation flying vs. a near miss with other traffic), the pilots reported that high workloads were a result. Also, regardless of the aircraft, such factors as fatigue and flight scheduling were found to be associated with high workloads. Operator errors were also reported to be contributing to high workloads, regardless of the aircraft type.

2. RECOMMENDATIONS

The data of this survey indicates high workloads associated with low-level operations. Also, the results of a recent USAFISC study found 90% of the ground impact accidents occurred during low-level flight (Reference 1). Consequently, it is highly recommended that those aircraft which fly a portion of their mission in the low-level envelope be further analyzed with regard to the severity and nature of the high workloads which reportedly occur.

It is recommended that the workloads and the associated causes for those aircraft which had a commonly reported problem (e.g., the KC-135 takeoff data computation, and the FB-111 enroute checklists/navigation procedures) be further analyzed for possible solutions.

Further, the information base resulting from this study should be used in conjunction with the development of next generation aircraft to provide foresight as to potential sources of high workload. The use of this data in conjunction with modernization and retrofit programs is also recommended.

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APPENDIX A

SURVEY FORM

IMPORTANT: READ THE INSTRUCTIONS SECTION ON THE COVER PAGE OF THIS PACKAGE BEFORE YOU BEGIN.

Recall and describe in detail a single accident, incident, or close call (reportable or nonreportable) or other event that resulted in degraded performance and/or a degraded mission which you feel was created by a high workload situation. The event must be one that YOU experienced in flight (nonsimulator) while operating your current aircraft (present or past tours). Do not omit any questions. Use additional sheets, if necessary.

1. *Describe the event (what happened?).*

2. *What occurred to indicate "trouble" (how did you find out about the problem)?*

3. *What was done (by you and/or others) to try to cope with/correct the problem?*

4. *How were the crew, aircraft, and/or mission (nearly) adversely affected?*

5. *What were the high workload conditions that created the above event? Describe your activities - both mental and physical - with relationship to your aircraft's controls and displays.*

6. *What specific factor(s) do you think contributed to or caused the workload problem?*

7. *Of all the times you have flown this aircraft, how frequently have you experienced this particular workload problem? Indicate the frequency by placing a short vertical line on the scale below.*

only once ———————————— *every flight*

OVER

Figure A-1. Survey Form (Front)

(8) What specific suggestions can you make for preventing a recurrence?

(9) What aircraft type and model were you flying?

______

(10) ...under what command?
- ☐ Tactical Air Command
- ☐ Strategic Air Command
- ☐ Military Airlift Command
- ☐ USAF in Europe
- ☐ Pacific Air Force
- ☐ Alaskan Air Command
- ☐ Other (specify): ______

(11) What was your mission (eg., close air support, search and rescue, reconnaissance, etc.)?

______

(12) On the average, how frequently did you fly this mission at the time of the event?

____ time(s) per __

(13) Was this mission...
- ☐ training
  - O routine
  - O Red Flag
  - O other (specify: ____)
- ☐ operational
  - O combat
  - O non-combat
  - O other (specify: ____)

(14) During which phase of the mission did the event occur?
- ☐ takeoff
- ☐ climb
- ☐ cruise
- ☐ low level flight (specify: _ 'AGL)
- ☐ weapon delivery
- ☐ aerial delivery
- ☐ refueling
- ☐ approach
- ☐ missed approach
- ☐ landing
- ☐ other: ____

(15) Describe the terrain...
- ☐ mountains
- ☐ water
- ☐ level
- ☐ rolling
- ☐ other (specify: ____)

(16) What time of day was it?
- ☐ dawn
- ☐ daylight
- ☐ dusk
- ☐ night

(17) Were you flying...
☐ VMC ☐ IMC

(18) Describe the weather (check all that apply)...
- ☐ restricted visibility
- ☐ turbulence
- ☐ thunderstorm
- ☐ aircraft icing
- ☐ crosswind
- ☐ precipitation
- ☐ none
- ☐ other (specify: ____)

(19) What was your crew position?
- ☐ aircraft commander
- ☐ copilot
- ☐ instructor pilot
- ☐ other (specify: ____)

Give your BEST ESTIMATE for Questions 20, 21, and 22.

(20) At the time of the described event, how many hours flying experience had you accumulated in this same aircraft type/model ...
- a. altogether? ____
- b. in combat only? ____

performing this mission type (in above aircraft)...
- c. altogether? ____
- d. in combat only? ____

(21) IF MULTICREW, how many hours had the exact same crew flown together prior to the event in this aircraft type model ...
- a. altogether? ____
- b. in combat only? ____

performing this mission type (in above aircraft)...
- c. altogether? ____
- d. in combat only? ____

(22) At the time of the described event, how many hours flying experience had you accumulated in ...
- a. all aircraft ____
- b. military aircraft only? ____
- c. combat only? ____

(23) What was your age at the time of the described event?

____ years old

(24) What was your military status at the time of the described event?
- a. rank: ____
- b. time in Air Force: ____ yrs ____ mos
- c. total pilot rated experience: ___ yrs __ mos

CHECK TO MAKE SURE THAT YOU HAVE ANSWERED ALL QUESTIONS.

Figure A-2. Survey Form (Back)

APPENDIX B

PARTICIPATING ORGANIZATIONS

Aircraft Type	Participating Organization
A-10A	81st Tactical Fighter Wing RAF Bentwaters/Woodbridge, England United States Air Forces in Europe (USAFE)
	355th Tactical Training Wing Davis-Monthan AFB, Arizona Tactical Air Command (TAC)
	354th Tactical Fighter Wing Myrtle Beach AFB, South Carolina Tactical Air Command (TAC)
	*57th Tactical Training Wing Nellis AFB, Nevada Tactical Air Command (TAC)
F-4	21st Composite Wing Elmendorf AFB, Alaska Alaskan Air Command (AAC)
	35th Tactical Fighter Wing George AFB, California Tactical Air Command (TAC)
	388th Tactical Fighter Wing Hill AFB, Utah Tactical Air Command (TAC)
	*57th Tactical Training Wing Nellis AFB, Nevada Tactical Air Command (TAC)
	52nd Tactical Fighter Wing Spangdahlem AB, Germany United States Air Forces in Europe (USAFE)
	401st Tactical Fighter Wing Torrejon AB, Spain United States Air Forces in Europe (USAFE)
F-5E	10th Tactical Reconnaissance Wing RAF Alconbury, England United States Air Forces in Europe (USAFE)

* All organizations whose names are precluded by asterisks were surveyed by both interview and questionnaire. All others were surveyed by questionnaire only.

Aircraft Type		Participating Organization
F-5E (Cont'd)		*57th Tactical Training Wing Nellis AFB, Nevada Tactical Air Command (TAC)
F-15A		*36th Tactical Fighter Wing Bitburg AB, Germany United States Air Forces in Europe (USAFE)
		32nd Tactical Fighter Squadron Camp New Amsterdam, Netherlands United States Air Forces in Europe (USAFE)
		49th Tactical Fighter Wing Holloman AFB, New Mexico Tactical Air Command (TAC)
		1st Tactical Fighter Wing Langley AFB, Virginia Tactical Air Command (TAC)
		57th Tactical Training Wing Nellis AFB, Nevada Tactical Air Command (TAC)
F-16		388th Tactical Fighter Wing Hill AFB, Utah Tactical Air Command (TAC)
F-105	(G)	35th Tactical Fighter Wing George AFB, California Tactical Air Command (TAC)
F-111	(D)	27th Tactical Fighter Wing Cannon AFB, New Mexico Tactical Air Command (TAC)
		48th Tactical Fighter Wing RAF Lakenheath, England United States Air Forces in Europe (USAFE)
	(A)	366th Tactical Fighter Wing Mountain Home AFB, Idaho Tactical Air Command (TAC)

* All organizations whose names are precluded by asterisks were surveyed by both interview and questionnaire. All others were surveyed by questionnaire only.

Aircraft Type		Participating Organization
F-111 (Cont'd)	(E, F)	57th Tactical Training Wing Nellis AFB, Nevada Tactical Air Command (TAC)
B-52		97th Bomb Wing Blytheville AFB, Arkansas Strategic Air Command (SAC)
		7th Bomb Wing Carswell AFB, Texas Strategic Air Command (SAC)
		92nd Bomb Wing Fairchild AFB, Washington Strategic Air Command (SAC)
		416th Bomb Wing Griffiss AFB, New York Strategic Air Command (SAC)
		42nd Bomb Wing Loring AFB, Maine Strategic Air Command (SAC)
		*320th Bomb Wing Mather AFB, California Strategic Air Command (SAC)
		19th Bomb Wing Robins AFB, Georgia Strategic Air Command (SAC)
FB-111A		*509th Bomb Wing Pease AFB, New Hampshire Strategic Air Command (SAC)
		380th Bomb Wing Plattsburg AFB, New York Strategic Air Command (SAC)
C-5A		443rd Military Airlift Wing Altus AFB, Oklahoma Military Airlift Command (MAC)

* All organizations whose names are precluded by asterisks were surveyed by both interview and questionnaire. All others were surveyed by questionnaire only.

Aircraft Type	Participating Organization
C-5A (Cont'd)	436th Military Airlift Wing Dover AFB, Delaware Military Airlift Command (MAC)
	*60th Military Airlift Wing Travis AFB, California Military Airlift Command (MAC)
C-130	374th Tactical Airlift Wing Clark AFB, Phillipines Military Airlift Command (MAC)
	616th Military Airlift Group Elmendorf AFB, Alaska Military Airlift Command (MAC)
	314th Tactical Airlift Wing Little Rock AFB, Arkansas Military Airlift Command (MAC)
	62nd Military Airlift Wing McChord AFB, Washington Military Airlift Command (MAC)
	*317th Tactical Airlift Wing Pope AFB, North Carolina Military Airlift Command (MAC)
	*435th Tactical Airlift Wing Rhein-Main AFB, Germany Military Airlift Command (MAC)
C-141A	443rd Military Airlift Wing Altus AFB, Oklahoma Military Airlift Command (MAC)
	436th Military Airlift Wing Dover AFB, Delaware Military Airlift Command (MAC)
	314th Tactical Airlift Wing Little Rock AFB, Arkansas Military Airlift Command (MAC)

* All organizations whose names are precluded by asterisks were surveyed by both interview and questionnaire. All others were surveyed by questionnaire only.

Aircraft Type	Participating Organization
C-141A (Cont'd)	438th Military Airlift Wing McGuire AFB, New Jersey Military Airlift Command (MAC)
	*60th Military Airlift Wing Travis AFB, California Military Airlift Command
CH-53	601st Tactical Control Wing Sembach AB, Germany United States Air Forces in Europe (USAFE)
KC-135A	97th Bomb Wing Blytheville AFB, Arkansas Strategic Air Command (SAC)
	7th Bomb Wing Carswell AFB, Texas Strategic Air Command (SAC)
	92nd Bomb Wing Fairchild AFB, Washington Strategic Air Command (SAC)
	416th Bomb Wing Griffiss AFB, New York Strategic Air Command (SAC)
	42nd Bomb Wing Loring AFB, Maine Strategic Air Command (SAC)
	*320th Bomb Wing Mather AFB, California Strategic Air Command (SAC)
	19th Bomb Wing Robins AFB, Georgia Strategic Air Command (SAC)

* All organizations whose names are precluded by asterisks were surveyed by both interview and questionnaire. All others were surveyed by questionnaire only.

Aircraft Type	Participating Organization
UH-1	35th Tactical Fighter Wing George AFB, California Tactical Air Command (TAC)
	1st Tactical Fighter Wing Langley AFB, Virginia Tactical Air Command (TAC)
	57th Tactical Training Wing Nellis AFB, Nevada Tactical Air Command (TAC)
HC-130	616th Military Airlift Group Elmendorf AFB, Alaska Military Airlift Command (MAC)
	39th Aero Rescue and Reconnaissance Wing Eglin AFB, Florida Military Airlift Command (MAC)
	41st Rescue and Weather Reconnaissance Wing McClellan AFB, California Military Airlift Command (MAC)
HH-1	39th Aero Rescue and Reconnaissance Wing Eglin AFB, Florida Military Airlift Command (MAC)
HH-3	616th Military Airlift Group Elmendorf AFB, Alaska Military Airlift Command (MAC)
	39th Aero Rescue and Reconnaissance Wing Eglin AFB, Florida Military Airlift Command (MAC)
HH-53	39th Aero Rescue and Reconnaissance Wing Eglin AFB, Florida Military Airlift Command (MAC)
	41st Rescue and Weather Reconnaissance Wing McClellan AFB, California Military Airlift Command (MAC)

* All organizations whose names are precluded by asterisks were surveyed by both interview and questionnaire. All others were surveyed by questionnaire only.

Aircraft Type	Participating Organization
O-2A	602nd Tactical Air Control Wing Bergstrom AFB, Texas Tactical Air Command (TAC)
	27th Tactical Air Support Squadron Davis-Monthan AFB, Arizona Tactical Air Command (TAC)
	25th Tactical Air Support Squadron Eielson AFB, Alaska Alaskan Air Command (AAC)
	15th Air Base Wing Hickam AFB, Hawaii Pacific Air Forces (PACAF)
	507th Tactical Air Control Wing Shaw AFB, South Carolina Tactical Air Command (TAC)
OV-10A	602nd Tactical Air Control Wing Bergstrom AFB, Texas Tactical Air Command (TAC)
	601st Tactical Control Wing Semback AB, Germany United States Air Forces in Europe (USAFE)
RF-4C	10th Tactical Reconnaissance Wing RAF Alconbury, England United States Air Forces in Europe (USAFE)
	363rd Tactical Reconnaissance Wing Shaw AFB, South Carolina Tactical Air Command (TAC)
	26th Tactical Reconnaissance Wing Zweibrucken AB, Germany United States Air Forces in Europe (USAFE)
SR-71	*9th Strategic Reconnaissance Wing Beale AFB, California Strategic Air Command (SAC)

* All organizations whose names are precluded by asterisks were surveyed by both interview and questionnaire. All others were surveyed by questionnaire only.

Aircraft Type	Participating Organization
U-2R	*9th Strategic Reconnaissance Wing Beale AFB, California Strategic Air Command (SAC)
E-3A	552nd Airborne Wing and Control Wing Tinker AFB, Oklahoma Tactical Air Command (TAC)
EC-135	15th Air Base Wing Hickam AFB, Hawaii Pacific Air Forces (PACAF)
	1st Tactical Fighter Wing Langley AFB, Virginia Tactical Air Command (TAC)
	513th Tactical Airlift Wing RAF Mildenhall, England United States Air Forces in Europe (USAFE)
	55th Strategic Reconnaissance Wing Offutt AFB, Nebraska Strategic Air Command (SAC)
	552nd Airborne Wing and Control Wing Tinker AFB, Oklahoma Tactical Air Command (TAC)

* All organizations whose names are precluded by asterisks were surveyed by both interview and questionnaire. All others were surveyed by questionnaire only.

APPENDIX C

INSTRUCTIONS TO SURVEY RESPONDENTS

AIR FORCE FLIGHT DYNAMICS LABORATORY

SURVEY OF OPERATIONAL WORKLOAD PROBLEMS AND THEIR CAUSES

BACKGROUND

The Air Force Flight Dynamics Laboratory, which is one of the Wright Aeronautical Laboratories under Air Force Systems Command located at Wright-Patterson Air Force Base, Ohio, is conducting a program in which pilots, like yourself, are being surveyed in order to identify operational workload problems and their causes. This program is being performed by the Crew Systems Development Branch, with the support of Bunker Ramo Corporation.

The survey, which consists of contacting pilots by mailed questionnaire, is an attempt to identify workload problems that adversely affect flight performance and/or mission completion. Although we recognize that crew members other than pilots also experience workload problems, we are restricting our sample to pilots during this phase of study.

The collected data will be analyzed in terms of aircraft type, mission type, problem type. etc., and published as a Flight Dynamics Laboratory report. The data will also be reformatted and a computerized data base established. These findings will be used to identify problem areas that need to be addressed, concurrent with present aircraft redesign programs and/or future aircraft development programs, in order to prevent the continuation of these problems and enhance aircrew performance and flight safety.

We believe that your expertise in operating your current aircraft and your familiarity with its mission(s) make you a vital link in our effort to identify these workload problems and their causes. It is because of our reliance upon your expertise that we ask you to take the 15-30 minutes necessary to complete the attached survey form.

We have designed our survey method to protect your anonymity, and any information you provide will be used only in the accomplishment of this program. Please complete the attached questionnaire, insert it in the enclosed, pre-addressed envelope, and return it to the Air Force Flight Dynamics Laboratory.

As with any mailed survey, our ability to use the information you provide is dependent upon the time, effort and candidness you expend. The Air Force Flight Dynamics Laboratory is keenly aware of the bother mailed surveys can be and, therefore, we are most appreciative of your participation. If you desire clarification of any of the items in the questionnaire, or have any other questions, please contact one of the persons below. Further, if you desire to be included in the distribution of our final report, contact one of the following individuals:

Ms. Debbie Warner, Bunker Ramo Corporation	Autovon: 785-3708 or 785-4608
Mr. Sam Herron, Bunker Ramo Corporation	785-6895 or 785-6696
Mr. Larry Butterbaugh, Flight Dynamics Laboratory	785-3708 or 785-4608

INSTRUCTIONS

Read the introductory paragraph of the questionnaire carefully. Then, using as much detail as you are able to accurately recall, provide answers for Questions 1-24.

If you wish, more than one type of workload problem may be related on additional paper as a separate questionnaire. If you do so, however, be sure to provide complete answers for all 24 questions contained in the questionnaire.

If the specific workload problem you address is a recurring one, select the most critical occurrence to describe. Or, if the circumstances surrounding this recurring problem differ significantly (eg., mission type, mission phase, weather, etc.), you may wish to treat the events separately by completing additional questionnaires.

Remember: Cite only one occurrence per questionnaire so that all of the information on each questionnaire pertains exclusively to the specific event you relate.

DO NOT USE YOUR NAME OR THE NAMES OF PERSONS WHOSE ACTIONS YOU DESCRIBE.

Figure C-1. Instruction Sheet for Mailed Survey

AIR FORCE FLIGHT DYNAMICS LABORATORY

SURVEY OF OPERATIONAL WORKLOAD PROBLEMS AND THEIR CAUSES

The Air Force Flight Dynamics Laboratory, one of the Wright Aeronautical Laboratories under Air Force Systems Command located at Wright Patterson Air Force Base, Ohio, is conducting a program in which pilots, like yourself, are being surveyed in order to identify operational workload problems and their causes. This program is being performed by the Crew Systems Development Branch, with the support of Bunker Ramo Corporation.

The study, which consists of contacting pilots by personal interview, is an attempt to identify workload problems that adversely affect flight performance and/or mission completion. Although we recognize that crew members other than pilots also experience workload problems, we are restricting our sample to pilots during this phase of study.

We believe that your expertise in operating your current aircraft and your familiarity with its mission(s) make you a vital link in our effort to identify these workload problems and their causes. It is because of our reliance upon your expertise that you are asked to participate in the interviews when our team of researchers comes to your base. A local point of contact has been established to schedule the interviews; he will inform you of your interview date and time.

You will be asked to recall and describe in detail a single accident, incident, or close call (reportable or nonreportable) or other event that resulted in degraded performance and/or a degraded mission which you feel was created by a high workload situation. The event must be one that YOU experienced in flight (nonsimulator) while operating your current aircraft (present or past tours). (Note: More than one event may be related to the interviewer, if you wish.)

The collected data will be analyzed in terms of aircraft type, mission type, problem type, etc., and published as a Flight Dynamics Laboratory report. The data will also be reformatted and a computerized data base established. These findings will be used to identify problem areas that need to be addressed, concurrent with present aircraft redesign programs and/or future aircraft development programs, in order to prevent the continuation of these problems and enhance aircrew performance and flight safety.

We have designed our survey method to protect your anonymity. The interviewer will not tape record your comments, but will instead make written notes during the discussion. Any information you provide will be noted exclusive of names. All participation is on an elective basis.

As with all studies of this nature, our ability to effectively use the information you provide is dependent upon the time, effort and candidness you expend. The Air Force Flight Dynamics Laboratory is most appreciative of your willingness to participate. If you have any questions about our study, we will be glad to answer them at the time of the interview; or if you wish, you may telephone one of the interviewers listed below. Further, if you desire to be included in the distribution of our final report, you may let us know either by telephone or at the time of the interview. We look forward to talking with you.

Ms. Debbie Warner	Autovon:	785-3708
Bunker Ramo Corporation		785-4608
Mr. Sam Herron		785-6895
Bunker Ramo Corporation		785-6696
Mr. Larry Butterbaugh		785-3708
Flight Dynamics Laboratory		785-4608

Figure C-2. Instruction Sheet for Personal Interviews

APPENDIX D

SURVEY CHARACTERISTICS

TABLE D-1

RESPONSE RATE FOR QUESTIONNAIRES AND INTERVIEWS BY AIRCRAFT TYPE AND SURVEY METHOD

Aircraft Type	Survey Method		
	Number of Questionnaires Mailed	Number of Questionnaires Returned	Response Rate, Questionnaire
A-10	203	61	30%
F-4	208	31	15
F-5	33	4	12
F-15	183	31	17
F-16	100	8	8
F-105	20	2	10
F-111	133	22	16
B-52	215	33	15
FB-111	50	6	10
C-5	150	13	9
C-130	235	37	16
C-141	250	22	9
CH-53	25	0	0
KC-135	250	29	12
UH-1	20	19	95
HC-130	45	2	4
HH-1	100	5	5
HH-3	35	1	3
HH-53	35	2	6
O-2	180	21	12
OV-10	35	11	31
RF-4	120	9	8
SR-71	5	0	0
U-2	5	0	0
E-3	25	7	24
EC-135	85	11	13
Total	2745	387	

TABLE D-1 (Cont'd)

Aircraft Type	Survey Method: Number of Interviews Scheduled	Number of Interviews Conducted[1]	Total Number of Interviews and Questionnaires	Percent of Sample (N=573)
A-10	4	5	66	11.52
F-4	6	7	38	6.63
F-5	14	14	18	3.14
F-15	18	21	52	9.08
F-16	0	0	8	1.40
F-105	0	0	2	.35
F-111	0	1	23	4.01
B-52	15	15	48	8.38
FB-111	15	18	24	4.19
C-5	15	18	31	5.41
C-130	35	40	77	13.44
C-141	15	18	40	6.98
CH-53	0	0	0	0.00
KC-135	17	18	47	8.20
UH-1	0	0	19	3.32
HC-130	0	0	2	.35
HH-1	0	0	5	.87
HH-3	0	0	1	.17
HH-53	0	0	2	.35
O-2	0	0	21	3.66
OV-10	0	0	11	1.92
RF-4	0	0	9	1.57
SR-71	3	3	3	.52
U-2	8	8	8	1.40
E-3	0	0	7	1.22
EC-135	0	0	11	1.92
Total	165	186	573	100.00 (67.5% Questionnaires) (32.5% Interviews)

[1] Interviewees (as well as questionnaire respondents) were encouraged to relate more than one event; therefore, the actual number of responses (186) exceeds the number of pilots contacted (165) for interviews.

TABLE D-2

QUESTIONNAIRES MAILED AND RETURNED, AND INTERVIEWS RECORDED BY USAF COMMAND

Aircraft Type	Tactical Air Command			Strategic Air Command		
	Number of Questionnaires Mailed	Number of Questionnaires Returned	Number of Interviews Conducted	Number of Questionnaires Mailed	Number of Questionnaires Returned	Number of Interviews Conducted
A-10	153	46	5			
F-4	98	10	3			
F-5	3	2	13			
F-15	123	17	1			
F-16	100	8				
F-105	20	1				
F-111	103	13	1			
B-52				215	33	15
FB-111				50	6	18
C-5						
C-130		3			1	
C-141						
CH-53						
KC-135				250	28	17
UH-1	20	3				
HC-130						
HH-1						
HH-3						
HH-53						
O-2	130	13				
OV-10	10					
RF-4	60					
SR-71				5		3
U-2				5		7
E-3	25	6				
EC-135	30	2		20	4	
SUBTOTAL	875	124	23	545	72	60
Response Rate for Questionnaires		(14.2%)			(13.2%)	
TOTAL (Questionnaire & Interview)		147			132	

TABLE D-2 (Cont'd)

Aircraft Type	Military Airlift Command: Number of Questionnaires Mailed	Number of Questionnaires Returned	Number of Interviews Conducted	United States Air Force in Europe: Number of Questionnaires Mailed	Number of Questionnaires Returned	Number of Interviews Conducted
A-10				50	13	
F-4				60	9	1
F-5				30	2	
F-15				60	12	20
F-16						
F-105						
F-111				30	7	
B-52						
FB-111						
C-5	150	13	18			
C-130	235	32	30			10
C-141	250	21	17			
CH-53				25		
KC-135						
UH-1	45	12				
HC-130	100	2				
HH-1	35	5				
HH-3	35	1				
HH-53		2				
O-2						
OV-10				25	9	
RF-4				60	7	
SR-71						
U-2						
E-3						
EC-135				25	2	
SUBTOTAL	850	88	65	365	61	31
Response Rate for Questionnaires		(10.3%)			(16.7%)	
TOTAL (Questionnaires & Interviews)		153			92	

TABLE D-2 (Cont'd)

Aircraft Type	Pacific Air Force: Number of Questionnaires Mailed	Pacific Air Force: Number of Questionnaires Returned	Pacific Air Force: Number of Interviews Conducted	Alaskan Air Command: Number of Questionnaires Mailed	Alaskan Air Command: Number of Questionnaires Returned	Alaskan Air Command: Number of Interviews Conducted
A-10						
F-4		1	1	50	4	
F-5						
F-15						
F-16						
F-105		1				
F-111		1				
B-52						
FB-111						
C-5						
C-131						
C-141						
CH-53						
KC-135					1	
UH-1						
HC-130						
HH-1						
HH-3						
HH-53						
O-2	20	6		30	2	
OV-10		2				
RF-4						
SR-71						
U-2						
E-3						
EC-135	10	1				
SUBTOTAL	30	12	1	80	7	0
Response Rate for Questionnaires		(40.0%)			(8.8%)	
TOTAL (Questionnaires & Interviews)		13			7	

TABLE D-2 (Cont'd)

Aircraft Type	Other USAF Commands: Number of Questionnaires Returned	Other USAF Commands: Number of Interviews Conducted	No Answer: Number of Questionnaires Returned	No Answer: Number of Interviews Conducted	Total of Questionnaire & Interviews Recorded
A-10			2		66
F-4			7	2	38
F-5				1	18
F-15			2		52
F-16					8
F-105					2
F-111			1		23
B-52					48
FB-111					24
C-5					31
C-130			1		77
C-141			1	1	40
CH-53					0
KC-135				1	47
UH-1			4		19
HC-130					2
HH-1					5
HH-3					1
HH-53					2
O-2					21
OV-10					11
RF-4			2		9
SR-71					3
U-2				1	8
E-3			1		7
EC-135	1		1		11
TOTAL	1	0	22	6	N=573

TABLE D-3

NUMBER OF QUESTIONNAIRE/INTERVIEW RESPONDENTS RELATING EVENTS, RECURRING SITUATIONS, OR GENERAL GRIPES

Survey Method	Type of Response: Events	Recurring Situations	General Gripes	None	Total
Questionnaire	307	34	7	39	387
Interview	95	12	68	11	186
Total	402	46	75	50	573

The above results, it is suspected, occurred because a respondent, in an interview was unable to relate a specific event and viewed the session as an opportunity to relate concerns about the operation of his aircraft. However, a questionnaire respondent probably did not feel at liberty to divert from the format of the questionnaire, and thus, in most cases, responded only if he had an event to relate.

The remaining tables illustrate the characteristics of the sample collected, including the crew positions occupied by the pilot and various measures of pilot/crew experience. (The respondents were asked to describe pilot/crew experience at the time of the event; however, for "recurring situations" and "general gripes" one could assume that, of those who gave a response, the data was probably current.)

TABLE D-4

CREW POSITION OF RESPONDENTS BY TYPE OF RESPONSE

Crew Position	Type of Response: Events	Recurring Situations	General Gripes	None	Total
Aircraft Commander	246	26	25	13	310
Copilot	80	7	7	1	95
Instructor Pilot	58	9	5	1	73
Other	12	0	1	0	13
NA or Unknown	6	4	37	35	82
Total	402	46	75	50	573

Of those pilots relating events whose crew positions at the time of the event were identifiable (i.e., not "NA or Unknown"), 62 percent were aircraft commanders, 20 percent were copilots, and 15 percent were instructor pilots.

TABLE D-5

HOURS TOTAL FLYING EXPERIENCE (INCLUDES ALL MILITARY, COMMERCIAL AND PRIVATE FLYING) BY TYPE OF RESPONSE

Hours of Total Flying Experience	Type of Response: Events	Recurring Situation	General Gripes	None	Total
1-500	33	0	0	2	35
501-1000	72	4	3	5	84
1001-1500	54	3	5	6	68
1501-2000	67	10	12	3	92
2001-2500	61	8	5	1	75
2501-3000	48	5	7	1	61
3001-3500	21	4	7	0	32
3501-4000	16	0	12	0	28
4001-4500	8	3	1	0	12
4501-5000	6	2	3	0	11
5001-5500	1	1	2	0	4
5501-6000	5	0	2	0	7
6001-6500	0	1	1	0	2
6501-7000	0	0	1	0	1
7001-7500	1	0	0	0	1
7501-8000	2	0	0	0	2
8001-8500	0	0	0	0	0
8501-9000	2	0	0	0	2
9001-9500	0	0	0	0	0
9501-10000	1	0	0	0	1
NA or Unknown	4	5	14	32	55
Total	402	46	75	50	573

Of the "known" responses (i.e., not "NA or Unknown") from pilots relating events, eight percent reported fewer than 500 hours total flying experience prior to the event related; 26 percent reported fewer than 1000 hours; 56 percent reported less than 2000 hours; 83 percent reported fewer than 3000 hours; and 93 percent reported fewer than 4000 hours. Only three percent of these pilots reported more than 5000 hours total flying experience prior to the time of the related event.

TABLE D-6

HOURS MILITARY FLYING EXPERIENCE BY TYPE OF RESPONSE

Hours of Military Flying Experience	Type of Response: Events	Recurring Situations	General Gripes	None	Total
1-500	41	1	0	2	44
501-1000	70	3	5	5	83
1001-1500	53	7	4	5	69
1501-2000	68	10	11	3	92
2001-2500	64	5	6	1	76
2501-3000	41	5	7	1	54
3001-3500	22	3	6	0	31
3501-4000	15	0	12	0	27
4001-4500	6	3	2	0	11
4501-5000	5	2	2	0	9
5001-5500	0	1	3	0	4
5501-6000	5	0	2	0	7
6001-6500	0	1	0	0	1
6501-7000	0	0	0	0	0
7001-7500	1	0	0	0	1
7501-8000	3	0	0	0	3
8001-8500	0	0	0	0	0
8501-9000	1	0	0	0	1
NA or Unknown	7	5	15	33	60
Total	402	46	75	50	573

For military flying experience only, and of the known responses from pilots relating events, 28 percent had fewer than 1000 hours; 59 percent reported less than 2000 hours; 85 percent indicated they had had less than 3000 hours military flight experience; and 95 percent indicated fewer than 4000 hours. Three percent of these pilots reported more than 5000 hours military flying time prior to the related event.

TABLE D-7

HOURS COMBAT FLYING EXPERIENCE BY TYPE OF RESPONSE

	Type of Response				
Hours of Flying Experience	Events	Recurring Situations	General Gripes	None	Total
0	188	19	19	11	237
1-500	85	10	19	2	116
501-1000	55	7	17	2	81
1001-1500	21	1	3	0	25
1501-2000	4	0	2	0	6
2001-2500	0	0	0	0	0
2501-3000	0	0	0	0	0
3001-3500	0	1	0	0	1
NA or Unknown	49	8	15	35	107
Total	402	46	75	50	573

Of the known responses by pilots who related events, 53 percent had had no military combat experience prior to the event. Of the remaining 166 respondents in this category, 51 percent reported fewer than 500 hours, 85 percent reported less than 1000 hours, and 98 percent reported fewer than 1500 hours.

TABLE D-8

HOURS FLYING EXPERIENCE IN CURRENT AIRCRAFT BY TYPE OF RESPONSE

	Type of Response				
Hours of Flying Experience	Events	Recurring Situations	General Gripes	None	Total
1-500	226	16	25	10	227
501-1000	74	9	13	4	100
1001-1500	30	10	10	3	53
1501-2000	44	3	5	0	52
2001-2500	11	2	3	1	17
2501-3000	10	0	2	0	12
3001-3500	2	2	2	0	6
3501-4000	2	0	0	0	2
4001-4500	0	0	0	0	0
4501-5000	0	0	0	0	0
5001-5500	0	0	1	0	1
5501-6000	1	0	0	0	1
NA or Unknown	2	4	14	32	52
Total	402	46	75	50	573

Discounting the "unknown" responses, 99 percent of the respondents who related events had flown in their current aircraft fewer than 3000 hours prior to the event and 57 percent had flown fewer than 500 hours on their current aircraft.

TABLE D-9

HOURS FLYING EXPERIENCE PERFORMING STATED MISSION TYPE
IN CURRENT AIRCRAFT BY TYPE OF RESPONSE

	Type of Response				
Hours of Flying Experience	Events	Situations	Gripes	None	Total
0	10	0	2	0	12
1-500	267	20	16	10	313
501-1000	54	12	10	0	76
1001-1500	16	5	7	3	31
1501-2000	17	0	1	0	18
2001-2500	3	1	1	0	5
2501-3000	3	0	1	0	4
3001-3500	0	0	0	0	0
3501-4000	2	0	0	0	2
4001-4500	0	0	0	0	0
4501-5000	0	0	0	0	0
5001-5500	0	0	1	0	1
NA or Unknown	30	8	36	37	111
Total	402	46	75	50	573

Of the "known" responses from pilots reported events, 74 percent had had fewer than 500 hours experience flying the stated mission in their current aircraft prior to the event and 98 percent had experienced fewer than 2000 hours.

TABLE D-10

HOURS COMBAT FLYING EXPERIENCE IN CURRENT AIRCRAFT
BY TYPE OF RESPONSE

	Type of Response				
Hours of Flying Experience	Events	Recurring Situations	General Grips	None	Total
0	258	27	37	13	335
1-500	44	3	9	1	57
501-1000	10	4	5	0	19
1001-1500	4	0	0	0	4
NA or Unknown	86	12	24	36	158
Total	402	46	75	50	573

Not taking into account the "unknown" responses, pilots relating events with 0 hours of combat experience in their current aircraft numbered 82 percent while those reporting less than 500 hours numbered 96 percent.

TABLE D-11

HOURS COMBAT FLYING EXPERIENCE PERFORMING STATED MISSION IN
CURRENT AIRCRAFT BY TYPE OF RESPONSE

	Type of Response				
Hours of Flying Experience	Events	Recurring Situations	General Gripes	None	Total
0	255	23	26	11	315
1-500	28	3	5	1	37
501-1000	1	1	2	0	4
1001-1500	1	0	0	0	1
NA or Unknown	117	19	42	38	216
Total	402	46	75	50	573

Ninety percent of the pilots relating events (ignoring the "unknown" responses) reported no experience performing the stated mission in combat in their current aircraft prior to the event.

The following data was acquired to describe the "same crew" experience i.e., the number of hours the same identical flight deck crew had flown together prior to the event described.

TABLE D-12

HOURS "SAME CREW" FLYING EXPERIENCE IN CURRENT AIRCRAFT
BY TYPE OF RESPONSE

	Type of Response				
Hours of Flying Experience	Events	Recurring Situations	General Gripes	None	Total
0	80	4	13	1	98
1-500	173	12	4	1	190
501-1000	2	1	0	0	3
NA or Unknown (Includes single crew aircraft)	147	29	58	48	282
Total	402	46	75	50	573

Thirty-one percent of the pilots relating events (disregarding the NA or Unknown responses) reported no "same crew" experience in their current aircraft prior to the event; 99 percent reported less than 500 hours "same crew" experience.

TABLE D-13

HOURS OF "SAME CREW" FLYING EXPERIENCE PERFORMING STATED MISSION IN CURRENT AIRCRAFT BY RESPONSE TYPE

Hours of Flying Experience	Type of Response: Events	Recurring Situations	General Gripes	None	Total
0	90	3	13	0	106
1-500	151	12	3	1	167
501-1000	1	0	0	0	1
1001-1500	0	1	0	0	1
NA or Unknown (Includes single crew aircraft)	160	30	59	49	298
Total	402	46	75	50	573

Thirty-seven percent of the pilots relating events (disregarding the NA or Unknown responses) reported no "same crew" experience flying the stated mission in their current aircraft prior to the event; 62 percent reported from one to 500 hours "same crew" experience under the same conditions.

TABLE D-14

HOURS OF "SAME CREW" COMBAT FLYING EXPERIENCE IN CURRENT AIRCRAFT BY RESPONSE TYPE

Hours of Flying Experience	Type of Response: Events	Recurring Situations	General Gripes	None	Total
0	203	12	15	1	231
1-500	4	1	0	0	5
NA or Unknown (Includes single crew aircraft	195	33	60	49	337
Total	402	46	75	50	573

Less than two percent of the pilots who related events (disregarding the NA or Unknown responses) reported having had any "same crew" experience in combat flying their current aircraft prior to the event. A similarly low number of respondents (2.55%) in this category reported "same crew" experience performing the stated mission in combat while flying their current aircraft.

TABLE D-15

HOURS OF "SAME CREW" COMBAT FLYING EXPERIENCE PERFORMING STATED MISSION IN CURRENT AIRCRAFT BY RESPONSE TYPE

Hours of Flying Experience	Type of Response: Events	Recurring Situations	General Gripes	None	Total
0	191	13	15	1	220
1-500	5	1	0	0	6
NA or Unknown (Includes single crew aircraft)	206	32	60	49	347
Total	402	46	75	50	573

APPENDIX E

EXPLANATION OF "MISSION" CATEGORIES

MISSION CLASSIFICATION

Mission classification was according to major aircraft categories as follows: fighter, bomber, transport/tanker, search and rescue, reconnaissance/observation, and special duty. Specific missions within each major are identified along with a description.

Fighter Missions	Air Superiority
	Air Defense
	Air-To-Ground
	Air-To-Ground (Nuclear Delivery)
	Ferry
	Unknown

Missions grouped under Air Superiority were those that operated primarily in the classical air-to-air role while those coded Air Defense, operated from an alert, scramble, and intercept configuration.

Air-to-ground missions included close-air-support (CAS) and interdiction missions involving primarily low-level navigation and gunnery, rockets/missile, and bomb delivery. Those identified as A/G nuclear delivery involved tactics specifically associated with the delivery of nuclear munitions.

Missions coded Ferry included deployments, with or without formation implications, cross country flights and aircraft pickup/delivery missions.

The Unknown category was used when the specific mission was not identified by the crewmember and was not obvious from his description of the event. Aircraft proficiency and instrument training missions were also placed in this category.

Bomber Missions	Low-Level Radar Bomb Scoring (RBS)
	Strategic Bomb (Hi-Level)
	High-Level Conventional Bomb
	Ferry
	Unknown

Missions were coded low-level RBS when specified by the pilot or when his description of the circumstances under which the event occurred clearly established that he was in the low-level RBS segment of a longer, multi-segmented mission

Ferry and Unknown were used in the same context as in fighter missions described above.

Transport/Tanker Missions	Logistic's Transportation (Ground-to-Ground)
	Strategic Airlift
	Airdrop (Tactical)
	Paratroop Drop
	Low-Altitude Parachute Extraction
	Air Refueling (Tanker)
	Passenger Transportation
	Ferry
	Unknown

Logistic's transportation was used for routine transportation missions such as site/station resupply and scheduled or unscheduled parts, supply or equipment movements. Strategic Airlift covered primarily long-range equipment moves. Airdrop (tactical) included single and multi-aircraft, mostly low altitude equipment drops. A majority of those falling in this category involved formation flight, the use of Station Keeping Equipment (SKE) and the All-Weather Aerial Delivery System (AWADS). Paratroop drop was used when pilots specified that the mission was for paratroop drop and circumstances with regard to the event did not fall into Airdrop. Air-refueling was used for KC-135 air refueling missions.

Search and Rescue Missions	Patient Pickup (MEDIVAC)
	Aircrew Recovery
	Rescue Escort
	Unknown
Reconnaissance/Observation Missions	Close Air Support
	Weather Reconnaissance
	Low Level Reconnaissance
	Strategic Reconnaissance (High Level)
	Unknown

A majority of the missions coded Close Air Support for this class of mission were Forward Air Controller (FAC) missions flown in 0-2/OV-10 aircraft. The Weather RECON mission involved a weather check in support of bombing/ gunnery range operations. Low Level Reconnaissance missions were fighter (RF-X) while Strategic Reconnaissance missions were flown in 0-2/SR-71 type aircraft.

Special Duty Missions	Airborne Command and Control
	Missile Site Support
	Range Support
	Air Defense
	Special Airlift
	Unknown

Missile Site Support missions were helicopter operations transporting personnel and parts/equipment to outflying missile sites while Range Support sorties were similar operations in support of bombing/gunnery range activities. Missions coded Air Defense were specified as such by pilots and described events which occurred prior to the time that Air Defense Command flight missions were transferred to the Tactical Air Command. Special Airlift missions were those designated for VIP transportation.

APPENDIX F

EXPLANATION OF "WORKLOAD CAUSE" CATEGORIES

Primary causes of high workload were divided into five major areas. The first area related to control/display or crew station design; the second related to aircraft/mission standard operating procedures; the third area related to training and training preparedness causes; the fourth related to equipment malfunction causes; and the fifth related high workload to a broad class of other causes.

I. Control/Display and Crew Station Design
   A. Controls *
      1. Mislocation
      2. Design Deficiency
   B. Information (Displays, Warnings, etc.)*
      1. Mislocation
      2. Design Deficiency
   C. Crew Station
      1. Configuration
      2. Environment
      3. Lighting

*The Controls (A) and Information (B) categories were broken down further into individual systems. Equipments considered in each system are described:

<u>Aircraft Fuel System</u>

This category covered the entire fuel system up to, but not including, the engine fuel control unit. System displays, provisions for fuel management, and transfer were grouped in this category.

<u>Communications Systems</u>

The intercommunications system and comm radios were included in this category.

<u>Electrical System</u>

This included components, controls and displays for the A-C and D-C systems, battery, generator(s), inverters, etc.

Engine Fuel Control System

This category addressed power controls, displays, and fuel scheduling.

Environmental System

This category included the air conditioning and pressurization systems, temperature and pressurization controls, and associated displays.

Flight Control System

This included individual control surfaces, automatic flight control system, stability augmentation devices, etc..

Hydraulic System

This covered the basic hydraulic system controls and displays and any problems (landing gear, speed brake, etc.) caused by hydraulic system discrepancies.

Navigation System

Components considered as part of the navigation system included the INS, navigation radios, and navigation displays, including components of the HSI and SKE.

Oil System

Oxygen System

This category included system controls, displays, supply, masks and associated hoses, and accessories.

Propulsion System

Included engine controls, power and engine operating displays excluding those covered under other categories such as oil system, engine fuel system, etc..

Weapons System

This category covered controls, displays, delivery computations, sensors, and weapons.

Other System(s)

This category included miscellaneous systems and equipment which included the IFF.

II. Training/Training Preparedness

A. For aircraft type

B. For mission type

C. For a given sortie

D. For a given crew position

III. Aircraft/Mission Standard Operating Procedures

A. Communications

B. Navigation

C. Checklist

D. Aircraft subsystem (Other than 1. or 2.)

IV. Equipment Malfunctions

This section addressed component or system malfunctions and degradation. The same aircraft systems categories as used previously apply.

V. Other

This category covered a variety of causes. During the questionnaire/interview review it was found that, almost invariably, one or more of these factors was in some way involved in the overall problem. Factors placed in this category were:

A. External aircraft markings, color, lights, etc.

B. External aircraft structure, frame design, etc.

C. Carry-on information aids (maps, FLIP charts, etc.)

D. Apparel

E. External Aircraft Systems

1. Windscreen - Pilot complaints about accumulations of dirt/bugs at low level, outer windshield fogging, glare caused by dirt films, delamination, etc., were included in this category.
2. Lighting - This group included external light failures, distractions caused by reflections (rotating beacon in the weather, etc.) or the lack of adequate external lighting.

3. Frame - Includes any external structural components of the aircraft.
4. Flight Control - Includes attitude control surfaces, lift, and drag devices.
5. Stores, cameras, etc. - Hung ordnance or problems with external pods, fuel tanks, etc., were included in this group.
6. Landing gear - Included here were problems with gear extention or retraction, etc.
7. Other - Pitot-static system, blown tire, etc.

F. Other aircraft, birds, terrain, obstructions, formation flight, threat, etc.

Included in this group were near misses between aircraft, including those in a formation, near crashes during low level operations, bird strikes, and real or simulated air-to-air or ground-to-air threats.

G. Ground Equipment/Ground Personnel

This included ground guidance (radar or nav aid) failures, ground controller errors, or maintenance personnel induced problems including faulty repairs or excessive delays in aircraft availability.

H. Flight Scheduling

This included last minute changes in missions, direction to proceed with a mission subsequent to excessive maintenance or weather delays, schedules that tested the limits of crew rest requirements and heavy scheduling to meet proficiency or flying hour requirements.

I. Pressure (ops, wing, etc.)/get-home-itis/stress under evaluation, etc.

Included in this group were factors such as implied or real pressure to excel or complete a mission in spite of factors which might dictate otherwise. Conflicting instructions, re-direct and excessive "help" in the form of questioning, redundant procedures, etc. from the Command Post or other supervisory agency are also included in this area.

J. Cargo (change in CG, emissions, etc.)

This was established to cover shifting cargo, fluid or gas emissions or other cargo related problems in flight that impacted on flight crew workload.

K. Environment

This included operation in adverse weather, poor visibility, darkness, etc. Pilot complaints about glare, external reflections, turbulence, and crosswind effects were placed in this category.

L. Operator Error

Operator error was identified when a workload situation was created or aggravated by an error on the part of a crewmember. The error could be one of commission or omission on the part of any member of the flight crew or the crew of another aircraft directly involved in the event.

M. Crew Fatigue/Spatial Disorientation

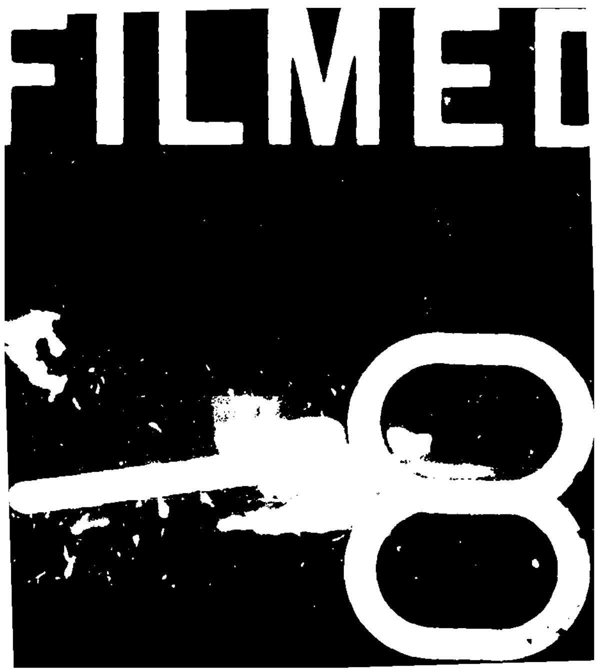
This category covered a variety of physiological effects ranging from the classical "tired" at the end of a long crew duty day to the frustrations a crew experiences subsequent to a series of maintenance delays or aircraft changes leading to late departures and in-flight re-planning. Spatial disorientation was included here also and included a range from loss of orientation requiring the assistance of another pilot to temporary loss of attitude awareness and entry into our unusual attitude.

N. Other

This category was used to cover miscellaneous causes not identified in other areas, such as instructor duties.

O. Language Problems

During the review it was found that pilots involved in overseas operations identified language difficulties as a source of or contributor to high workload. Accordingly, this factor was added to the list as a separate item.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